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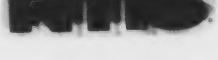

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The report presents the results of the U.S. Environmental Protection Agency's 1987 National Ambient Air Audit Program by pollutant and by analytical method. Semiannual audits were conducted for CO, Pb, NO_3^- and $SO_4^=$ (filter strips) and acid rain, and an annual audit was conducted for particulate sampler flow rate. Continuous SO_2 monitors were audited throughout the year such that no monitor was audited more than once. Approximately 45 laboratories participated in each semiannual acid rain audit and in each NO_3^- and $SO_4^=$ audit and approximately 90 laboratories participated in each Pb audit. Five hundred and ninety-five CO monitors, 262 SO_2 monitors, and 1333 high volume flow samplers were also audited. The results for each 1987 audit are presented in tabular form for each concentration level. The overall performance for all participants for each audit conducted since the beginning of the program is also illustrated in a series of figures.

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AMBIENT AIR AUDITS OF ANALYTICAL PROFICIENCY
-1987-

by

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This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

This report presents the results of the U.S. Environmental Protection Agency's 1987 National Ambient Air Performance Audit Program by pollutant and by analytical method. Semiannual audits were conducted for Pb, No_3^- and $SO_4^=$ on filter strips and for acid rain and CO. One audit was conducted for high-volume sampler flow rate. Continuous SO_2 monitors were audited throughout the year, with no monitor being audited more than once. The results for each 1987 audit are presented in tabular form for each concentration level. The overall performance for all participants for each audit conducted since the beginning of the program is also shown graphically. The results of the 1987 audits are essentially the same as those from the audits conducted from 1983 to 1986.

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SECTION 1

INTRODUCTION

The National Performance Audit Program (NPAP) for ambient air is conducted by the Atmospheric Research and Exposure Assessment Laboratory (AREAL) of EPA at Research Triangle Park, NC. NPAP provides EPA management a means to assess the compliance of agencies operating monitors in the SLAMS (State and Local Air Monitoring System) network to one aspect of the minimum QC program required under Section 2.0 of 40 CFR Part 58, Appendix A. The NPAP complements the biannual systems audits conducted on the SLAMS network by the EPA regional offices. Organizations operating SLAMS samplers and PSD samplers are required by 40 CFR 58 to participate in the appropriate NPAP audits.

Although participation is mandatory, organizations operating SLAMS and PSD samplers can benefit from participation in NPAP because it provides them a means to compare their performance on the audit to that obtained by all organizations who participated in that audit. Participation in the NPAP can also identify out-of-control situations in the participant's QC program. However, an organization cannot validly use NPAP data to adjust or invalidate monitoring data unless there is a basis for doing so from its internal QC program.

Until the 1987 audits, potential NPAP participants were primarily identified using input from the EPA regional offices and the previous year's mailing lists. This system was only moderately effective in assuring that organizations operating SLAMS and PSD sites participated in the NPAP as required under 40 CFR Part 58. Significant improvements were made in this area in 1987 due to changes in the SLAMS regulations that required each agency to report their precision and accuracy data from each monitor. Additional improvements were made in the 1988 audits and by 1989 we expect to be able to identify all organizations that must participate in the NPAP.

In 1987, audits were done on the following criteria air pollutants: SO_2, CO, high volume/PM-10 size selective inlet sampler (flow only), and lead (analysis only). In 1989, audits will be initiated for dichot sampler (flow only), NO_2 and O_3. The addition of these audits will permit EPA to audit all the criteria air pollutant measurements under NPAP. Audits for sulfate and nitrate on filter strips and for acid rain are also done under the NPAP program for reasons of cost. These latter non-criteria pollutant audits, which check only the analytical portion of the method, are optional and are open to governmental, academic and commercial organizations. (Most of the criteria pollutant audits are restricted to SLAMS and PSD site operators.)

Approximately 450 organizations participated in NPAP in 1987. The total number of participants has remained essentially unchanged since 1984 for all the audits concerned with criteria pollutants and for the sulfate and nitrate audits. There was a 7 percent increase in the acid rain audit from 1985 to 1986 and this increase remained in the 1987 audits. The number of participating organizations and/or samplers audited are summarized in Table 1 for the 1987 audits. The percentage of the participants by organization type is also presented in this table. Both the percentage of participation by organization type and the number of participants/samplers audited has remained quite constant since 1984 for all audits.

All participants receive an evaluation of their performance shortly after the audit is completed. When practical, those submitting abnormally high or low results are offered an opportunity to analyze another set of samples. However, the retest results are not included in this summary report. In any case, participants with excessively deviant values can investigate their operations to identify and correct the cause of the large errors.

Throughout this report, reference is made to "assigned values." These values are the standards against which reported results are evaluated and have been so designated after consideration of the analytical results of the referee laboratory, the QAD/AREAL Standards Laboratory, and the manufacturer of the audit material.

The audit materials used in the NPAP in 1987 are described below.

CARBON MONOXIDE AUDIT

These audit materials consist of a mixture of CO, CO_2 and CH_4 and zero air in a disposable pressurized gas cylinder that simulates an ambient air sample. Directions specify that the gas sample be introduced into a continuous analyzer in the "sample" mode to permit the analyzer to draw the sample in the same fashion and at the same flow rate as during ambient air monitoring.

SULFATE, NITRATE, AND LEAD ON FILTER STRIPS

The filter strip samples used are 1.9 cm wide by 20 cm long. They are cut from 20- by 24-centimeter glass fiber filters, spiked with an aqueous solution of the appropriate solution and oven dried. After analysis, pollution concentrations are computed by assuming that the samples were collected on the prescribed high volume filter with a sample air volume of 2000 m^3. Six sample strips comprise a set. The sulfate, nitrate, and lead samples were prepared from aqueous solutions of sodium sulfate, potassium nitrate, and lead nitrate, respectively.

PM-10(SSI)/HIGH VOLUME FLOW AUDIT

The reference flow (ReF) device used for this audit consists of a modified orifice, a wind deflector, a manometer, and five resistance plates.

A single ReF device is supplied to each participating agency with instructions to check samplers at as many sampling sites as feasible. Before use in the audit, each ReF device is calibrated with a positive displacement meter traceable to the National Bureau of Standards (NBS). During the audit, the device is mounted on top of the sampler and replaces the filter faceplate. The wind deflector is then positioned to prevent fluctuations in the measurements due to wind blowing across the orifice.

SULFUR DIOXIDE CONTINUOUS MONITORS

The auditing device for the SO_2 continuous ambient air monitors is a dilution system that provides a mechanism to control the quantity of SO_2 and diluent air that are mixed and then passed into the monitor. The flow rate of each gas is controlled by maintaining a predetermined pressure drop across a porous plug flow restrictor, and the SO_2 concentration is changed by using different combinations of these flow restrictors.

The audit device, which is housed in a compact, lightweight, impact-resistant case, is constructed so that only the controls needed to operate the system are exposed. By opening and closing different toggle valves, it is possible to generate up to seven preset pollutant concentrations. Five are used for the audit. Two compressed gas cylinders are supplied with each unit, one as the SO_2 source and the other as the dilution air source. Each audit device is calibrated at the five settings used in the audit with the flow calibration referenced to laminar flow elements traceable to NBS flow standards.

ACID RAIN

Five aqueous solutions in polyethylene bottles containing the anions and cations found in rain water are shipped to each of the participating organizations. All samples are diluted 1:50 by the participant. Three of the five samples are analyzed for pH, conductivity, acidity and the major cations and anions normally measured in precipitation samples and the other two samples are analyzed for heavy metals. The latter two samples are acid stabilized to prevent loss of metals from the solution during shipment.

The chemical composition of these samples is certified by using an NBS standard reference material (SRM). The participants analyze the samples using the analytical procedures they normally employ when analyzing precipitation samples. The results are reported on the basis of the sample concentration after the 1:50 dilution.

SECTION 2

RESULTS AND DISCUSSION

The NPAP results do not warrant a sophisticated statistical analysis for a variety of reasons. For example, the summary statistics cannot be used to adjust the SLAMS data base, and an individual audit result cannot be used by itself to invalidate data from a SLAMS or PSD monitor. Also, at this time, it is not possible to compare the precision and accuracy data reported for a SLAMS monitor to that obtained in the NPAP except at the local level. However, the NPAP data does provide a means to detect any general trends in the performance of organizations measuring criteria air pollutants. It also provides each participant an opportunity to compare his result to the results reported from all organizations that participated in the audit. The summary statistics and the figures in this report are adequate for these two latter purposes.

With the exception of the sulfur dioxide and the flow audit results, the results for the 1987 NPAP audits are summarized in tabular form using: the mean (same value as the median), the mean of the difference from the assigned value (% Acc.) and the standard deviation of the differences (% CV). The mean is the average of all the values reported for that concentration level. The data is presented with and without the outliers removed. Outliers were eliminated as follows. First the results from laboratories/sites whose values for all samples exceeded ± 20 percent of the assigned value were removed from the data base. The excluded values represented approximately 5% of the total number of results, which is approximately the same as for 1983 through 1986 (1, 2, 3, 4). Then, individual sample results were rejected as outliers based on Chauvenet's Criterion (5). After outliers were eliminated, the results from all participants were normally distributed.

At each audit level, the percent accuracy (% Acc.) and the precision, as measured by the percent coefficient of variation (% CV), were calculated using Equations 1 and 2, respectively. The percent accuracy measures how well the average of all participants agrees with assigned values. The percent coefficient of variation measures the variability among participants.

$$\% \text{ Acc.} = \frac{\text{audit mean} - \text{EPA assigned value}}{\text{EPA assigned value}} \times 100 \qquad (1)$$

$$\% \text{ CV} = \frac{\text{audit standard deviation}}{\text{audit mean}} \times 100 \qquad (2)$$

Overall accuracy and precision values for each audit were also calculated and plotted (Figures 1 through 23) to show the historical record of performance for each type of audit. All of the figures present the results of the performance audits after elimination of the outliers. Also, for each audit in which the % CV remained approximately constant over the range of audit levels, the average % Acc. can be considered a measure of the percent shift from an ideal slope of 1.00 for a regression line (with an intercept of zero) between the audit level mean and the EPA assigned value.

Overall, the performance of the organizations participating in the criteria air pollutant audits (lead, carbon monoxide, sulfur dioxide, hi-vol/SSI flow) has changed little since 1983. The types and numbers of monitors/analytical methods employed by the participants has also changed little. For example, the following observations on the 1987 NPAP audit also apply at least to the 1985-1986 audits and, in many cases, to the 1983-1984 audits.

Carbon Monoxide Audit (Tables 2, 3 and 4 and Figure 1). Approximately 85 percent of the monitors audited in 1987 used NDIR as their measurement principle and the other 15 percent used as filter correlation. As in earlier audits, both monitor types gave similar % Acc. and % CV results. Percent Acc. and % CV have not changed since 1980 (Figure 1), and the percent frequency distribution (Table 4) has been constant since 1983. For example, in the 0187 carbon monoxide audit, 98.7 percent of the results for the Level 2 sample were within 10 percent of the assigned value. This compares closely to values of 99.1 percent, 98.1 percent, 96.7 percent, and 96.9 percent reported for this sample in the 1986, 1985, 1984, and 1983 audits, respectively.

Sulfate Audit (Tables 5, 6 and 7 and Figure 2). The overall results have been essentially constant for % Acc. and % CV since 1983 (Figure 2). In 1986, the number of organizations participating dropped approximately 15 percent from the 1983-1985 audits, and then was constant from 1986 to 1987. Since 1983, the results for this audit have been very similar. For example, the manual methods have always had a larger % Acc. and % CV than the automated methods. Similarly, the automated methylthymol blue method has consistently yielded results that are less precise than the ion chromatographic method (Table 6). The only major change has been in the percent of organizations that used the ion chromatograph method. Between 1983 and 1985, 40% of the participants who used the automated methods analyzed the samples by ion chromatography. In 1986 this increased to 50 percent and in 1987 it increased to 70 percent of the automated analyses. The percent frequency distribution (Table 7) has also remained constant since 1983.

Nitrate Audit (Tables 8, 9 and 10 and Figure 3). The nitrate results are very similar to the sulfate results concerning the percent frequency distribution (constant from 1983 to 1987) and the shift from the automated cadmium reduction method to the ion chromatographic method (40 percent in 1983-1985, 60 percent in 1986, and 70 percent in 1987). Since 1984, both % Acc. and % CV have been reasonably constant (Figure 3), and the ion chromatographic method has consistently yielded a smaller % Acc. than the other automated analytical method (Table 9).

Lead Audit (Tables 11 and 12 and Figure 4). Since 1979, the % CV and the % Acc. have remained essentially unchanged (Table 11 and Figure 4). The percent frequency distribution (Table 12), the number of participants (90 to 100), and the percentage of the participants using atomic absorption (98 percent) has also remained constant.

Sulfur Dioxide Audit (Table 13). The number of monitors audited in 1987 (262) represents a slight increase from 1985 and 1986 when 245 monitors were audited. The fluorescence method continued to increase its share of the monitors checked; that is, in 1987 at least 95 percent of the 262 monitors audited used fluorescence as their measurement principle (the operating principle of 8 of the 262 monitors was not identified by the participant). This compares to 92 percent in 1986 and 90 percent in 1985. Because each sulfur dioxide audit device has unique dilution factors, it is possible only to provide the concentration range in ppb for each level, the mean difference in ppb for all results for a specific level (same as the median in absolute value), and the standard deviation in ppb about the mean difference. The results from the 1987 audit (Table 13) compare very closely to those from 1984 to 1986.

High Volume/PM-10 Size Selective Inlet (SSI) Flow Audit (Table 14). Approximately 1333 samplers were audited; aproximately 8 percent of the results were discarded because they were outliers. As in the 1984-1986 audits, samplers equipped with pressure transducers and rotameters were the most frequently audited samplers, comprising approximately 60 percent of the 1333 samplers audited for flow. Each NPAP audit device has unique calibration factors, so it is possible to provide only the approximate flow in m^3/min for each resistance plate. The audit data is reported only as percent difference and not in m^3/min. The data base is too large (4000 data points) to tabulate the results by hand and until new software is available (1989), we can report the results only in terms of the percentage difference from the audit device's assigned flow value. These results (Table 14) are essentially unchanged from those obtained between 1984 and 1986.

Acid Rain Audits (Tables 15 through 22 and Figures 5 through 23). Participation in this audit increased each year from 1983 to 1986, but then stabilized. One interesting feature is the high percentage of participants who represent state and local agencies; that is, between 55 percent and 75 percent of the participants in the eight NPAP audits conducted since 1984 have come from this group. Although there are 19 parameters that can be analyzed, most participants analyze only for pH (100 percent), conductivity (85-90 percent), and the major anions (60-70 percent). Less than 50 percent analyze for the major cations and less than 35 percent analyze for the six heavy metals and for acidity.

The audit results for 1987 are presented in Tables 15 through 22, and the performance of the particpants from a historical perspective are presented in Figures 5 through 23.

The short history of this audit, the small number of participants for most of the 19 parameters and the tendency for many of the participants to report their results to only one significant figure make it difficult to draw

conclusions about the sample results. The low concentrations in the sample mean that a small absolute difference (mg/L) can appear to be a large relative difference (% CV, % Acc.). Also, sometimes removing just one or two sample results yields a noticeable improvement in the % CV and % Acc. It is therefore recommended that the reader not scrutinize the tables, but rather inspect the historical performance of the audit participants as shown in Figures 5 through 23.

REFERENCES

1. Parr, B.F., R.L. Lampe, G. Pratt, O.L. Dowler and W.J. Mitchell. National Performance Audit Program. Ambient Air Audits of Analytical Proficiency, 1986. U.S. Environmental Protection Agency Report EPA 600/4-87-038. Research Triangle Park, North Carolina 27711. December 1987.

2. Parr, B.F., R.L. Lampe, G. Pratt, O.L. Dowler and W.J. Mitchell. National Performance Audit Program. Ambient Air Audits of Analytical Proficiency, 1985. U.S. Environmental Protection Agency Report EPA 600/4-87-002. Research Triangle Park, North Carolina 27711. January 1987.

3. Parr, B.F., R.L. Lampe, G. Pratt, O.L. Dowler and W.J. Mitchell. National Performance Audit Program. Ambient Air Audits of Analytical Proficiency, 1984. U.S. Environmental Protection Agency Report EPA 600/4-86-013. Research Triangle Park, North Carolina 27711. February 1986.

4. Lampe, R.L., B.F. Parr, G. Pratt, O.L. Dowler and W.J. Mitchell. National Performance Audit Program. Ambient Air Audits of Analytical Proficiency, 1983. U.S. Environmental Protection Agency Report EPA 600/4-84-077. Research Triangle Park, North Carolina 27711. October 1984.

5. Chauvenet, W. A Manual of Spherical and Practical Astronomy. J.B. Lipincott and Company, Philadelphia, Pennsylvania, 1863. pp. 558-566.

TABLE 1. AGENCY PARTICIPATION

Survey	Distribution (%)					No. of Laboratories[a]	No. of Monitors[a]
	States	Local	Industry	Federal	Foreign		
CO -- January 1987	47.0	44.8	3.0	1.6	3.9	145 (1)	305 (1)
CO -- July 1987	42.4	49.3	5.2	0.3	2.8	142 (2)	290 (2)
SO_4 -- February 1987	42.0	20.0	30.0	2.0	6.0	50 (2)	--
SO_4 -- August 1987	48.9	20.9	20.9	2.3	7.0	43 (0)	--
NO_3 -- February 1987	44.4	17.8	28.9	2.2	6.7	45 (3)	--
NO_3 -- August 1987	47.2	22.2	19.4	2.8	8.3	36 (2)	--
Pb -- January 1987	42.5	25.8	26.4	1.1	4.2	94 (0)	--
Pb -- July 1987	41.6	30.3	24.7	1.1	2.2	89 (0)	--
SO_2 (continuous)	48.5	36.3	12.6	2.6	0.0	123 (0)	262 (0)
High-Volume Flow-Rate -- May 1987	41.1	42.8	14.8	0.5	0.8	192 (107)	1333 (107)
Acid Rain -- April 1987	50.0	22.5	15.0	12.5	0.0	40	--
Acid Rain -- October 1987	37.5	18.8	33.3	10.4	0.0	48	--

[a]Value in parentheses is the number of laboratories/monitors that reported all values off by more than ± 20% from the assigned value.

TABLE 2. AUDIT RESULTS FOR CARBON MONOXIDE

Audit	Level	n	Assigned value (ppm)	Mean (ppm)	% Acc.	% CV
			A. ALL DATA			
0187	1	301	8.10	8.24	1.73	4.00
	2	305	15.10	15.14	0.26	3.17
	3	305	34.40	34.15	0.73	2.81
0787	1	289	5.90	5.88	-0.34	5.95
	2	277	21.20	21.14	-0.28	2.93
	3	283	41.60	41.80	0.48	2.32
			B. OUTLIERS REMOVED			
0187	1	297	8.10	8.24	1.72	3.52
	2	300	15.10	15.15	0.33	2.77
	3	298	34.40	34.19	-0.61	2.28
0787	1	283	5.90	5.88	-0.34	5.95
	2	273	21.20	21.13	-0.33	2.70
	3	283	41.60	41.80	0.48	2.32

TABLE 3. AUDIT RESULTS FOR CARBON MONOXIDE BY THE NDIR AND GFC METHODS

Audit	Level	Assigned value (ppm)	NDIR Method n	NDIR Method Mean (ppm)	NDIR Method % Acc.	NDIR Method % CV	GFC Method n	GFC Method Mean (ppm)	GFC Method % Acc.	GFC Method % CV
				A. ALL DATA						
0187	1	8.10	202	8.27	2.09	4.83	90	8.21	1.36	2.44
	2	15.10	203	15.20	0.66	3.29	93	15.07	-0.20	2.00
	3	34.40	203	34.17	-0.67	3.00	93	34.15	-0.73	2.31
0787	1	5.90	166	5.86	-0.68	7.34	117	5.86	-0.68	5.29
	2	21.20	157	21.24	0.19	3.91	117	21.02	-0.85	2.52
	3	41.60	165	41.85	0.60	3.42	117	41.72	0.29	1.81
				B. OUTLIERS REMOVED						
0187	1	8.10	199	8.27	2.10	3.22	90	8.21	1.36	2.44
	2	15.10	199	15.20	0.66	2.87	92	15.06	-0.26	1.93
	3	34.40	196	34.24	-0.47	2.19	90	34.18	0.64	1.87
0787	1	5.90	163	5.88	-0.34	6.63	116	5.87	-0.51	4.60
	2	21.20	152	21.24	0.19	2.87	114	21.00	-0.94	2.05
	3	41.60	160	41.89	0.70	2.36	116	41.69	0.22	1.85

TABLE 4. PERCENT OF CARBON MONOXIDE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUES

Audit	Level	Assigned value (ppm)	10%	20%	30%	50%
		A. ALL DATA				
0187	1	8.10	95.7	98.4	98.7	98.7
	2	15.10	98.4	100.0	100.0	100.0
	3	34.40	98.4	100.0	100.0	100.0
0787	1	5.90	85.9	94.8	98.6	99.7
	2	21.20	94.8	96.2	96.6	96.6
	3	41.60	94.8	99.0	99.3	99.3
		B. OUTLIERS REMOVED				
0187	1	8.10	96.1	98.4	98.7	98.7
	2	15.10	98.7	100.0	100.0	100.0
	3	34.40	98.7	100.0	100.0	100.0
0787	1	5.90	86.5	97.9	98.6	98.3
	2	21.20	95.5	96.5	96.5	99.3
	3	41.60	98.3	99.3	96.5	99.3

TABLE 5. AUDIT RESULTS FOR SULFATE ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0287	1	50	1.78	1.91	7.30	56.02
	2	49	2.88	2.73	-5.21	20.15
	3	50	20.37	20.04	-1.64	16.27
	4	50	26.42	25.80	-2.35	14.53
	5	50	8.16	8.38	2.70	33.53
	6	50	6.30	6.34	0.63	36.12
0887	1	43	2.95	2.97	0.68	16.84
	2	42	2.13	2.21	3.76	25.34
	3	43	5.89	5.84	-0.85	12.84
	4	43	24.56	24.10	-1.87	5.22
	5	42	7.08	7.23	2.12	9.95
	6	43	21.68	21.57	-0.51	7.23
			B. OUTLIERS REMOVED			
0287	1	47	1.78	1.77	-0.56	27.69
	2	45	2.88	2.80	-2.78	8.57
	3	46	20.33	20.30	0.34	7.44
	4	46	26.42	26.37	-0.19	4.78
	5	47	8.16	7.96	-6.45	9.30
	6	47	6.30	6.16	2.22	8.44
0887	None removed					

TABLE 6. AUDIT RESULTS FOR SULFATE BY THE AUTOMATED METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	Methyl Thymol Blue n	Methyl Thymol Blue Mean ($\mu g/m^3$)	Methyl Thymol Blue % Acc.	Methyl Thymol Blue % CV	Ion Chromatograph n	Ion Chromatograph Mean ($\mu g/m^3$)	Ion Chromatograph % Acc.	Ion Chromatograph % CV
				A. ALL DATA						
0287	1	1.78	13	1.85	3.93	35.14	26	1.74	-2.25	11.49
	2	2.88	13	2.71	-5.90	11.81	26	2.75	4.51	8.36
	3	20.37	13	19.30	-5.25	21.40	26	20.50	0.64	9.85
	4	26.42	13	25.21	-4.58	19.12	26	26.16	-0.98	6.65
	5	8.16	13	9.52	16.67	51.16	26	7.96	-2.45	7.54
	6	6.30	13	7.53	19.52	54.71	26	6.10	-3.17	7.54
0887	1	2.95	11	2.97	0.67	14.81	24	2.94	-0.34	7 48
	2	2.13	10	2.09	-1.88	16.27	24	2.15	0.94	9.76
	3	5.89	11	5.51	-6.45	19.60	24	5.89	0.00	6.79
	4	24.59	11	24.42	-0.59	6.27	24	24.21	-1.43	4.09
	5	7.08	11	7.12	0.56	8.85	23	7.13	0.71	7.57
	6	21.68	11	22.06	-1.75	10.65	24	21.52	-0.74	5.76
				B. OUTLIERS REMOVED						
0287	1	1.78	11	1.80	1.12	8.89	24	1.79	0.56	6.70
	2	2.88	12	2.78	3.47	-7.19	25	2.77	-3.82	7.58
	3	20.37	12	20.41	0.20	4.95	24	20.06	-1.52	6.73
	4	26.42	12	26.53	0.42	3.20	24	26.15	-1.02	4.32
	5	8.16	12	8.18	0.25	5.74	24	7.95	-2.57	5.41
	6	6.30	12	6.39	1.43	5.48	26	6.10	-3.17	7.54
0887	None removed									

TABLE 7. PERCENT OF SULFATE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0287	1	1.78	58.0	78.0	80.0	88.0
	2	2.88	68.0	88.0	90.0	92.0
	3	20.37	76.0	90.0	94.0	96.0
	4	26.42	88.0	94.0	94.0	96.0
	5	8.16	76.0	90.0	92.0	96.0
	6	6.30	76.0	90.0	94.0	96.0
0887	1	2.95	65.1	86.0	93.0	97.7
	2	2.13	65.1	76.7	88.4	93.0
	3	5.89	76.7	93.0	97.7	97.7
	4	24.56	83.4	100.0	100.0	100.0
	5	7.08	69.8	90.7	97.7	97.7
	6	21.68	93.0	97.7	97.7	100.0
		B. OUTLIERS REMOVED				
0287	1	1.78	60.4	81.3	88.9	91.7
	2	2.88	70.8	91.7	93.8	93.8
	3	20.37	79.2	93.8	97.9	100.0
	4	26.42	91.7	97.9	97.9	100.0
	5	8.16	79.2	93.8	95.8	97.9
	6	6.30	79.2	93.8	97.9	100.0
0887	None removed					

TABLE 8. AUDIT RESULTS FOR NITRATE ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0287	1	45	0.59	0.65	10.17	43.08
	2	45	1.20	1.19	-0.83	31.09
	3	45	3.59	3.61	0.56	21.33
	4	45	8.22	8.08	-1.70	22.40
	5	45	12.02	11.96	-0.50	22.91
	6	45	13.12	13.10	-0.15	23.66
0887	1	36	1.25	1.28	2.40	21.89
	2	35	0.96	0.98	2.08	22.45
	3	36	4.16	4.11	-1.20	16.06
	4	36	8.77	8.61	-1.82	13.70
	5	35	12.43	12.12	-2.49	14.77
	6	36	13.61	13.10	-3.75	13.89
			B. OUTLIERS REMOVED			
0287	1	41	0.59	0.63	6.78	25.40
	2	40	1.20	1.21	0.83	11.57
	3	40	3.59	3.64	1.39	6.32
	4	40	8.22	8.25	0.36	5.33
	5	39	12.02	12.12	0.84	4.13
	6	41	13.12	13.14	0.15	8.45
0887	1	33	1.25	1.29	3.20	12.40
	2	31	0.96	0.98	2.08	13.27
	3	32	4.16	4.20	0.96	4.76
	4	33	8.77	8.87	1.14	4.62
	5	31	12.43	12.47	0.32	3.45
	6	33	13.61	13.53	-0.59	4.73

TABLE 9. AUDIT RESULTS FOR NITRATE BY THE AUTOMATED METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	Ion Chromatograph				Cadmium Reduction			
			n	Mean ($\mu g/m^3$)	% Acc.	% CV	n	Mean ($\mu g/m^3$)	% Acc.	% CV
				A. ALL DATA						
0287	1	0.59	24	0.58	-1.69	29.31	10	0.83	40.70	50.60
	2	1.20	24	1.16	-3.33	20.69	10	1.36	13.30	44.12
	3	3.59	24	3.50	-2.51	17.14	10	4.15	15.60	25.30
	4	8.22	24	7.74	-5.84	19.51	10	9.14	11.19	26.70
	5	12.02	24	11.42	-4.94	20.05	10	13.77	14.55	28.18
	6	13.12	24	12.76	-2.74	22.10	10	14.47	10.29	28.40
0887	1	1.25	22	1.24	-0.08	20.16	7	1.24	-0.08	16.13
	2	0.96	22	0.95	-1.04	23.16	6	0.89	-7.29	19.10
	3	4.16	22	3.96	-4.80	17.17	7	4.06	-2.40	11.82
	4	8.77	22	8.43	-3.87	16.13	7	8.50	-3.08	10.00
	5	12.43	21	11.81	-5.00	17.02	7	12.15	-2.25	11.69
	6	13.61	22	12.92	-5.07	16.41	7	12.79	-6.02	10.16
				B. OUTLIERS REMOVED						
0287	1	0.59	21	0.60	1.69	18.33	8	0.66	11.86	29.51
	2	1.20	22	1.22	1.67	10.65	8	1.25	4.16	5.60
	3	3.59	22	3.64	1.39	5.49	8	3.73	3.90	4.02
	4	8.22	22	8.10	-1.50	5.31	9	8.38	1.95	5.01
	5	12.02	22	11.97	-0.42	3.84	9	12.57	4.58	6.44
	6	13.12	22	13.06	-0.05	7.81	9	13.22	0.76	9.30
0887	1	1.25	19	1.28	2.40	7.03	6	1.28	2.40	14.06
	2	0.96	19	0.98	2.08	10.20	5	0.96	0.00	4.24
	3	4.16	20	4.14	-0.48	4.35	6	4.23	1.68	4.73
	4	8.77	20	8.75	-0.23	2.86	6	8.74	-0.34	7.09
	5	12.43	19	12.37	-0.43	2.59	6	12.67	1.93	2.13
	6	13.61	20	13.49	-0.88	2.52	6	13.17	-3.23	6.83

TABLE 10. PERCENT OF NITRATE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0287	1	0.59	42.2	64.4	75.6	82.2
	2	1.20	66.7	77.8	86.7	93.3
	3	3.59	77.8	88.9	91.1	95.6
	4	8.22	82.2	88.9	93.3	93.3
	5	12.02	82.2	88.9	93.3	95.6
	6	13.12	77.8	84.4	91.1	93.3
0887	1	1.25	50.9	75.0	91.7	94.4
	2	0.96	63.9	69.4	80.6	94.4
	3	4.16	83.3	88.9	94.4	97.2
	4	8.77	88.9	97.2	97.2	97.2
	5	12.43	86.1	86.1	94.4	94.4
	6	13.61	86.1	91.7	97.2	97.2
		B. OUTLIERS REMOVED				
0287	1	0.59	45.2	69.1	91.7	94.4
	2	1.20	71.4	83.3	80.6	91.7
	3	3.59	83.3	95.2	94.4	97.2
	4	8.22	88.1	95.2	97.2	97.2
	5	12.02	88.1	95.2	94.4	94.4
	6	13.12	83.3	90.5	97.2	97.2
0887	1	1.25	52.9	79.4	94.1	97.1
	2	0.96	67.6	73.5	85.3	94.1
	3	4.16	93.8	94.1	97.1	100.0
	4	8.77	94.1	100.0	100.0	100.0
	5	12.43	91.2	91.2	97.1	97.1
	6	13.61	91.2	97.1	100.0	100.0

TABLE 11. AUDIT RESULTS FOR LEAD ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0187	1	94	1.68	1.75	4.17	5.71
	2	94	0.55	0.60	9.09	15.00
	3	94	1.17	1.12	-4.27	5.36
	4	94	3.60	3.54	-1.67	6.78
	5	94	8.72	8.51	-2.41	5.41
	6	93	6.91	6.69	-3.18	10.76
0787	1	88	0.54	0.52	-3.70	19.23
	2	88	1.12	1.17	4.46	11.97
	3	89	1.98	2.02	2.02	11.39
	4	89	3.59	3.58	-0.28	10.89
	5	89	6.50	6.70	3.08	6.27
	6	89	7.00	7.01	0.14	8.42
			B. OUTLIERS REMOVED			
0187	None removed					
0787	None removed					

TABLE 12. PERCENT OF LEAD MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0187	1	1.68	88.3	98.4	98.4	100.0
	2	0.55	67.0	89.4	93.6	97.9
	3	1.17	90.4	98.4	100.0	100.0
	4	3.60	87.2	98.4	98.4	100.0
	5	8.72	88.3	100.0	100.0	100.0
	6	6.91	88.3	97.9	97.9	97.9
0787	1	0.54	75.2	93.3	94.4	95.5
	2	1.12	87.6	94.4	94.4	96.6
	3	1.98	88.8	94.4	97.7	98.9
	4	3.59	94.4	96.6	97.7	98.9
	5	6.50	91.0	97.7	98.9	100.0
	6	7.00	92.1	96.6	96.6	100.0
		B. OUTLIERS REMOVED				
0187	None removed					
0787	None removed					

TABLE 13. AUDIT RESULTS FOR SULFUR DIOXIDE CONTINUOUS MONITORS[a]

Flow setting	Number of monitors audited	Range of conc. (ppb)	Mean difference (ppb)	Std. dev. of the mean (ppm)
1	41	770-560	-32	49
2	242	510-360	-8	28
3	249	270-190	-3	17
4	249	210-140	-2	14
5	249	70-40	0	5.0
6	148	0	1	2.1

[a]Data is for only those monitors that use fluorescence as their measurement principle.

TABLE 14. PERCENT OF HIGH VOLUME FLOW MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE (ALL DATA)

Plate number	Number of measurements	Approximate flow (m^3/min)	10%	20%	30%	50%
5	521	0.7	72.6	89.9	94.6	98.5
7	719	0.9	83.6	93.7	97.4	99.2
10	872	1.1	86.7	96.2	98.2	99.6
13	905	1.2	88.8	96.7	98.3	99.5
18	908	1.3	89.8	96.9	98.2	99.7

TABLE 15. ACID RAIN RESULTS FOR pH, CONDUCTIVITY AND ACIDITY (ALL DATA)

Audit		Level	n	Assigned value	Mean	% Acc.	% CV
0487	pH	1	39	4.27	4.23	-0.89	6.8
		2	38	3.69	3.62	-1.92	6.8
		3	39	3.92	3.86	-1.45	6.5
	Conductivity (µS/cm)	1	35	24.5	26.3	7.47	64.2
		2	34	98.5	100.7	2.25	55.9
		3	35	65.1	70.0	7.65	52.7
	Acidity (µequiv/L)	1	14	54.5	77.4	42.03	83.1
		2	13	214.3	249.5	16.43	53.7
		3	14	124.3	148.7	19.69	67.4
1087	pH	1	48	4.51	4.47	-0.80	6.2
		2	48	3.91	3.86	-1.23	6.9
		3	48	3.57	3.55	-0.98	3.6
	Conductivity (µS/cm)	1	41	16.5	15.6	-5.20	12.3
		2	41	62.8	60.2	-4.03	9.4
		3	41	128.7	125.3	-2.61	8.0
	Acidity (µequiv/L)	1	16	33.4	52.4	56.9	97.1
		2	16	129.4	131.1	1.39	33.1
		3	16	285.3	282.1	-1.12	34.0

TABLE 16. ACID RAIN RESULTS FOR pH, CONDUCTIVITY AND ACIDITY (OUTLIERS REMOVED)

Audit		Level	n	Assigned value	Mean	% Acc.	% CV
0487	pH	1	38	4.27	4.27	0.00	3.4
		2	37	3.69	3.66	-0.87	1.9
		3	38	3.92	3.91	-0.46	2.0
	Conductivity (µS/cm)	1	34	24.5	23.4	-8.11	7.3
		2	33	98.5	91.5	-7.05	20.0
		3	34	65.1	63.8	-1.88	6.5
	Acidity (µequiv/L)	1	13	54.5	63.4	16.37	61.5
		2	12	214.3	219.8	2.58	38.3
		3	13	124.3	125.1	0.70	39.6
1087	pH	1	47	4.51	4.51	0.00	3.4
		2	47	3.91	3.90	-0.28	2.3
		3	47	3.57	3.55	-0.59	2.4
	Conductivity (µS/cm)	1	40	16.5	15.7	-4.29	10.3
		2	40	62.8	60.6	-3.52	8.4
		3	39	128.7	126.7	-1.51	6.3
	Acidity (µequiv/L)	1	15	33.4	40.7	21.92	51.2
		2	15	129.4	139.0	7.48	22.3
		3	15	285.3	299.8	5.10	22.4

TABLE 17. ACID RAIN AUDIT RESULTS FOR ANIONS (ALL DATA)

Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0487	SO_4 (reported as S)	1	26	0.90	1.25	38.0	65.0
		2	27	4.13	4.45	7.8	45.0
		3	28	2.13	2.74	28.0	55.0
	NO_3 (reported as N)	1	28	0.11	0.20	84.0	192.0
		2	27	0.12	0.21	75.0	187.0
		3	28	0.86	1.11	29.0	81.0
	Cl	1	25	0.29	0.45	55.0	144.0
		2	24	0.36	0.48	33.0	95.0
		3	25	1.12	1.26	10.0	46.0
	F	1	15	0.03	0.08	160.0	132.0
		2	14	0.09	0.16	80.0	121.0
		3	17	0.19	0.30	55.0	117.0
1087	SO_4 (reported as S)	1	32	0.52	0.62	18.0	44.0
		2	34	2.64	3.08	17.0	44.0
		3	34	3.76	3.73	0.7	28.0
	NO_3 (reported as N)	1	33	0.14	0.14	0.0	29.0
		2	33	0.11	0.10	9.9	31.0
		3	34	1.41	1.31	7.6	21.0
	Cl	1	32	0.39	0.41	5.4	37.0
		2	33	0.64	0.63	-1.5	14.0
		3	32	0.93	0.91	-1.9	15.0
	F	1	14	0.05	0.08	-60.0	95.0
		2	17	0.08	0.11	37.0	64.0
		3	18	0.25	0.34	36.0	124.0

TABLE 18. ACID RAIN AUDIT RESULTS FOR ANIONS (OUTLIERS REMOVED)

Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0487	SO_4 (reported as S)	1	24	0.90	1.07	19.0	51.0
		2	26	4.13	4.13	0.0	29.0
		3	25	2.13	2.25	5.6	22.0
	NO_3 (reported as N)	1	27	0.11	0.13	18.0	55.0
		2	26	0.12	0.14	19.0	51.0
		3	26	0.86	0.87	0.8	5.0
	Cl	1	23	0.29	0.27	-7.9	29.0
		2	23	0.36	0.39	8.3	37.0
		3	24	1.12	1.15	2.6	18.0
	F	1	13	0.03	0.04	30.0	46.0
		2	14	0.09	0.11	27.0	68.0
		3	16	0.19	0.21	11.0	30.0
1087	SO_4 (reported as S)	1	30	0.52	0.56	7.9	18.0
		2	32	2.64	2.76	4.6	15.0
		3	31	3.76	3.80	1.0	10.0
	NO_3 (reported as N)	1	31	0.14	0.14	0.0	20.0
		2	30	0.11	0.12	9.9	13.0
		3	32	1.41	1.37	-2.9	9.0
	Cl	1	31	0.39	0.38	-2.5	14.0
		2	32	0.64	0.62	-3.3	11.0
		3	31	0.93	0.90	-3.4	12.0
	F	1	13	0.05	0.07	40.0	74.0
		2	16	0.08	0.09	12.0	21.0
		3	17	0.25	0.24	4.2	22.0

TABLE 19. ACID RAIN RESULTS FOR CATIONS (ALL DATA)

Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0487	NH_3 (reported as N)	1	20	0.08	0.08	0.0	33.0
		2	20	0.61	0.64	6.1	24.0
		3	21	0.34	0.38	10.0	25.0
	Ca	1	21	0.05	0.12	120.0	148.0
		2	20	0.05	0.15	200.0	254.0
		3	22	0.16	0.20	25.0	92.0
	K	1	21	0.07	0.12	70.0	99.0
		2	20	0.08	0.11	38.0	52.0
		3	23	0.54	0.54	0.0	19.0
	Mg	1	21	0.03	0.04	33.0	105.0
		2	20	0.01	0.02	100.0	182.0
		3	22	0.06	0.08	33.0	68.0
	Na	1	23	0.18	0.26	42.0	71.0
		2	21	0.24	0.31	30.0	71.0
		3	23	1.32	1.39	5.3	22.0
1087	NH_3 (reported as N)	1	29	0.11	0.12	9.9	23.0
		2	29	0.61	0.61	0.0	14.0
		3	29	0.78	0.76	-2.5	21.0
	Ca	1	27	0.06	0.08	-33.0	138.0
		2	28	0.13	0.13	0.0	31.0
		3	22	0.01	0.08	700.0	312.0
	K	1	28	0.07	0.11	57.0	119.0
		2	28	0.08	0.12	50.0	119.0
		3	29	0.10	0.11	10.0	38.0
	Mg	1	27	0.01	0.02	100.0	26.0
		2	27	0.01	0.02	100.0	89.0
		3	27	0.05	0.05	0.0	25.0
	Na	1	29	0.24	0.26	8.2	56.0
		2	29	0.25	0.28	13.0	50.0
		3	28	0.49	0.51	4.5	28.0

TABLE 20. ACID RAIN AUDIT RESULTS FOR CATIONS (OUTLIERS REMOVED)

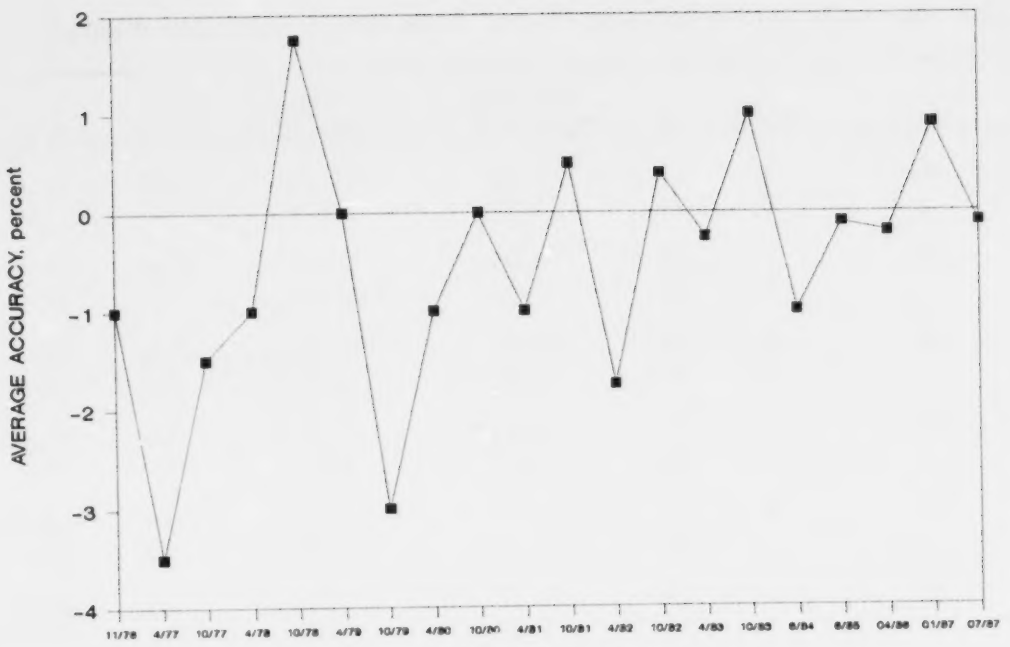
Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0487	NH_3 (reported as N)	1	18	0.08	0.09	12.0	10.0
		2	19	0.61	0.67	11.0	12.0
		3	19	0.34	0.38	5.8	11.0
	Ca	1	20	0.05	0.08	60.0	90.0
		2	19	0.05	0.07	40.0	48.0
		3	21	0.16	0.17	5.0	61.0
	K	1	20	0.07	0.10	42.0	62.0
		2	19	0.08	0.10	25.0	35.0
		3	20	0.54	0.55	2.6	8.0
	Mg	1	20	0.03	0.03	0.0	28.0
		2	19	0.01	0.01	0.0	35.0
		3	21	0.06	0.07	16.0	19.0
	Na	1	21	0.18	0.21	16.0	34.0
		2	20	0.24	0.27	12.0	33.0
		3	22	1.32	1.35	2.3	19.0
1087	NH_3 (reported as N)	1	27	0.11	0.12	9.9	14.0
		2	28	0.61	0.63	3.1	10.0
		3	27	0.78	0.79	1.7	13.0
	Ca	1	26	0.06	0.06	0.0	39.0
		2	26	0.13	0.13	0.0	20.0
		3	21	0.01	0.03	200.0	148.0
	K	1	27	0.07	0.09	30.0	28.0
		2	27	0.08	0.09	12.0	20.0
		3	28	0.10	0.11	10.0	24.0
	Mg	1	27	0.01	0.02	100.0	26.0
		2	25	0.01	0.01	0.0	21.0
		3	26	0.05	0.05	0.0	16.0
	Na	1	28	0.24	0.23	4.2	17.0
		2	28	0.25	0.26	4.0	27.0
		3	27	0.49	0.48	-2.0	10.0

TABLE 21. ACID RAIN AUDIT RESULTS FOR TRACE METALS (ALL DATA)

Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0487	Mn	4	12	0.05	0.05	0.0	20.0
		5	13	0.10	0.10	0.0	24.0
	Fe	4	11	0.05	0.06	20.0	27.0
		5	12	0.11	0.11	0.0	15.0
	Cd	4	12	0.03	0.03	0.0	14.0
		5	12	0.07	0.07	0.0	9.0
	Cu	4	11	0.05	0.05	0.0	21.0
		5	12	0.15	0.15	0.0	8.0
	Ni	4	10	0.07	0.08	15.0	12.0
		5	11	0.08	0.09	12.0	20.0
	Pb	4	13	0.12	0.14	16.0	42.0
		5	13	0.27	0.28	3.7	17.0
	Zn	4	11	0.09	0.09	0.0	14.0
		5	11	0.62	0.59	-4.6	10.0
1087	Mn	4	19	0.12	0.11	-8.1	23.0
		5	19	0.03	0.03	0.0	21.0
	Fe	4	19	0.07	0.08	15.0	23.0
		5	19	0.02	0.03	50.0	76.0
	Cd	4	19	0.14	0.14	0.0	9.0
		5	19	0.02	0.03	50.0	8.0
	Cu	4	18	0.20	0.21	5.0	7.0
		5	18	0.05	0.05	0.0	24.0
	Ni	4	18	0.12	0.12	0.0	16.0
		5	18	0.05	0.05	0.0	28.0
	Pb	4	18	0.43	0.42	-2.3	7.0
		5	18	0.13	0.13	0.0	11.0
	Zn	4	17	0.78	0.78	0.0	23.0
		5	17	0.15	0.15	0.0	9.0

TABLE 22. ACID RAIN AUDIT RESULTS FOR TRACE METALS (OUTLIERS REMOVED)

Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0487	Mn	4	11	0.05	0.05	0.0	14.0
		5	11	0.10	0.10	0.0	8.0
	Fe	4	10	0.05	0.07	40.0	16.0
		5	11	0.11	0.11	0.0	10.0
	Cd	4	12	0.03	0.03	0.0	14.0
		5	12	0.07	0.07	0.0	9.0
	Cu	4	11	0.05	0.05	0.0	21.0
		5	11	0.15	0.15	0.0	6.0
	Ni	4	10	0.07	0.08	15.0	12.0
		5	10	0.08	0.08	0.0	13.0
	Pb	4	12	0.12	0.12	0.0	12.0
		5	12	0.27	0.27	0.0	8.0
	Zn	4	11	0.09	0.09	0.0	14.0
		5	10	0.62	0.58	-6.9	6.0
1087	Mn	4	18	0.12	0.12	0.0	5.0
		5	17	0.03	0.03	0.0	9.0
	Fe	4	18	0.07	0.08	15.0	12.0
		5	18	0.02	0.02	0.0	38.0
	Cd	4	18	0.14	0.14	0.0	5.0
		5	19	0.02	0.03	50.0	8.0
	Cu	4	17	0.20	0.21	5.0	5.0
		5	17	0.05	0.06	20.0	10.0
	Ni	4	17	0.12	0.12	0.0	6.0
		5	17	0.05	0.05	0.0	13.0
	Pb	4	18	0.43	0.42	-2.3	7.0
		5	13	0.13	0.13	0.0	9.0
	Zn	4	16	0.78	0.83	9.2	3.0
		5	16	0.15	0.16	6.7	4.0



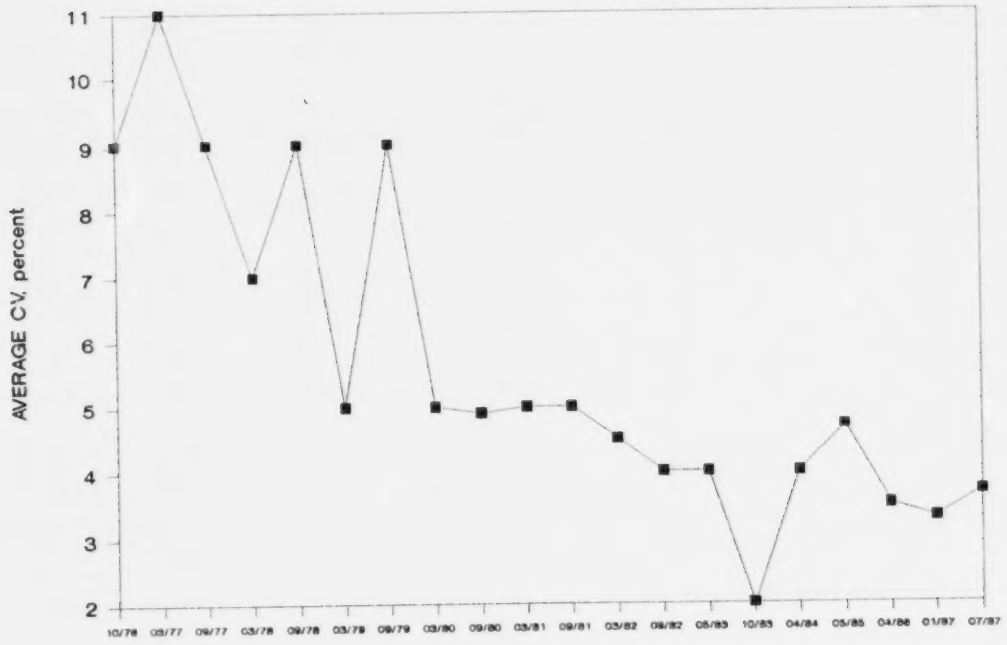
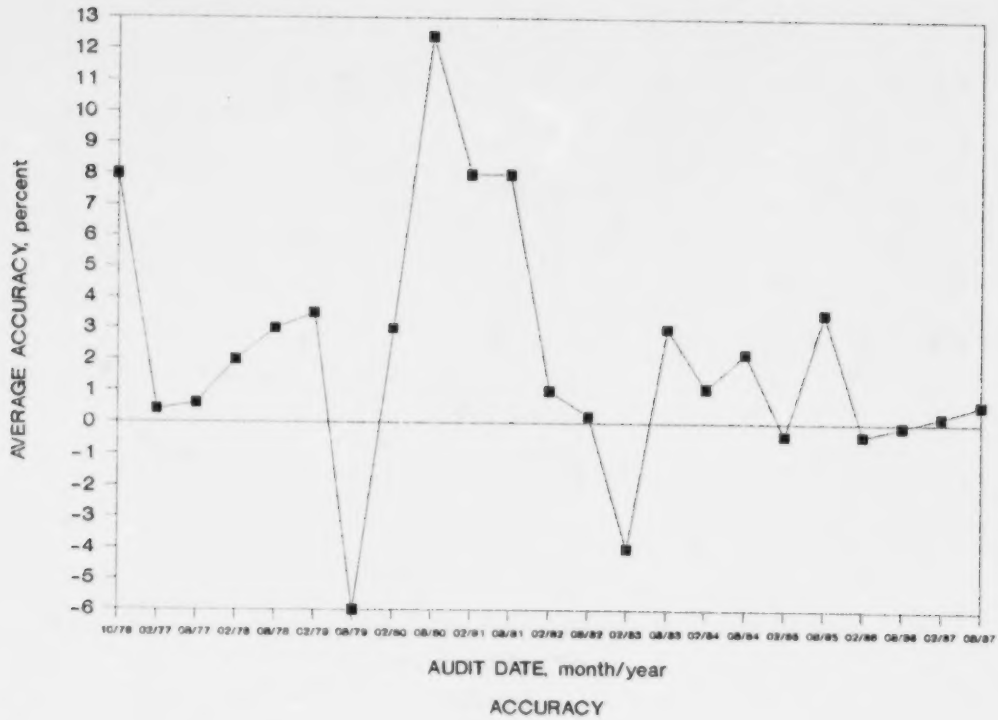


Figure 1. Carbon Monoxide Audits



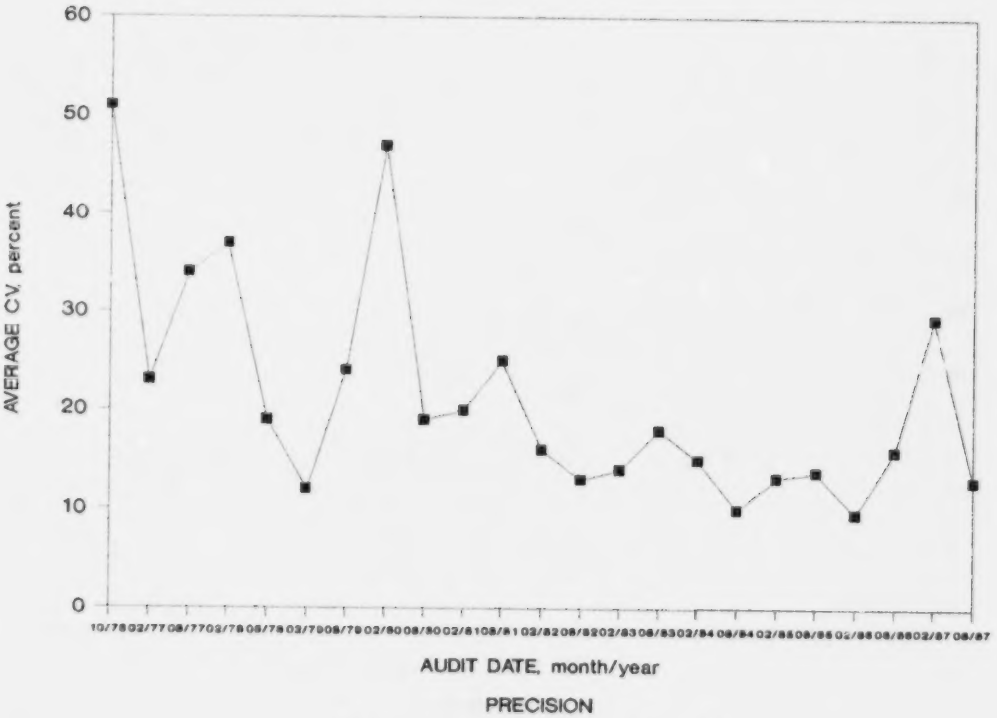
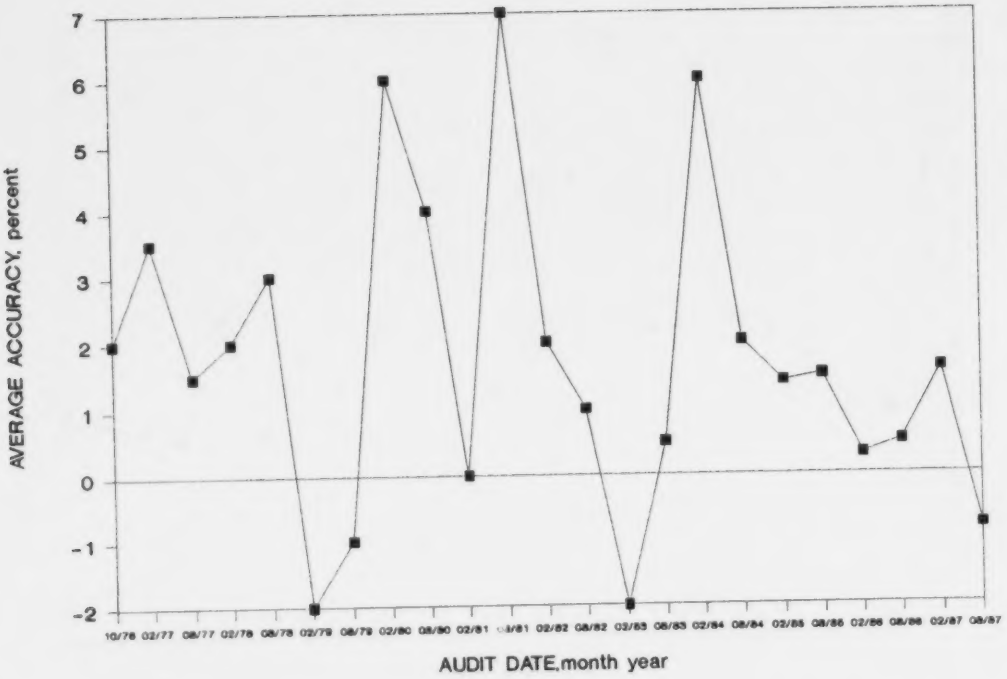


Figure 2. Sulfate Audits



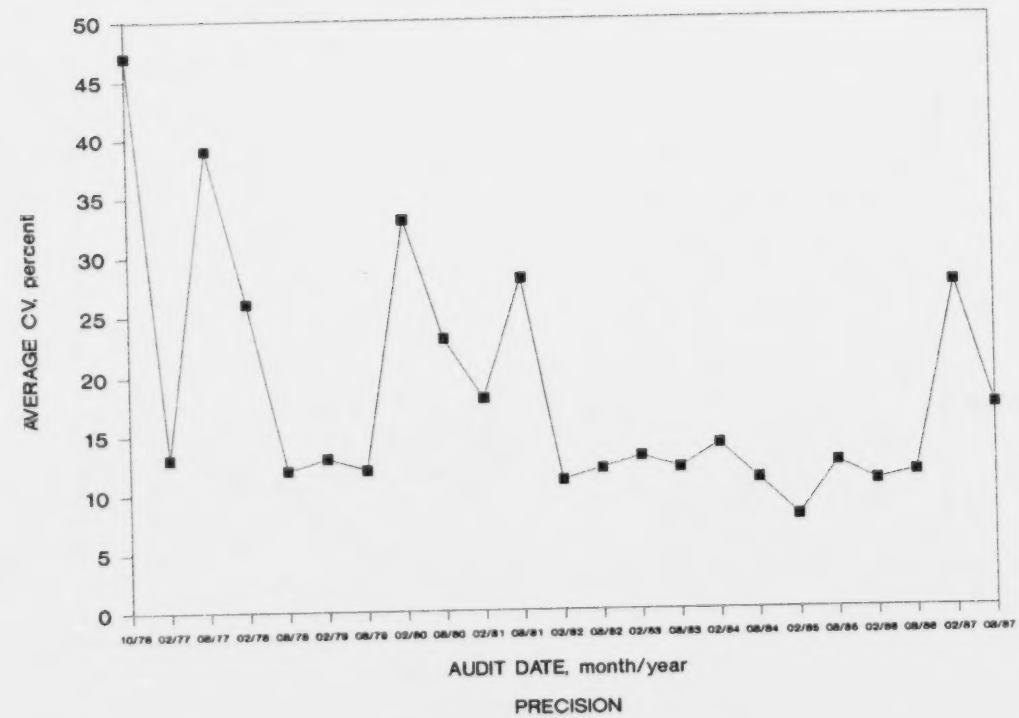
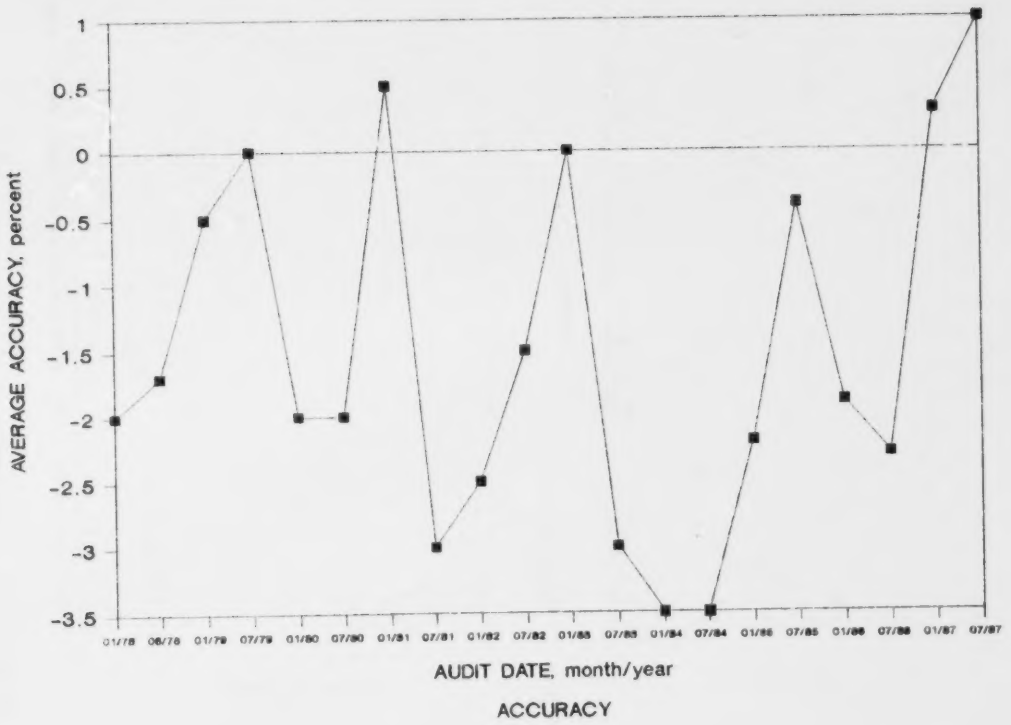


Figure 3. Nitrate Audits



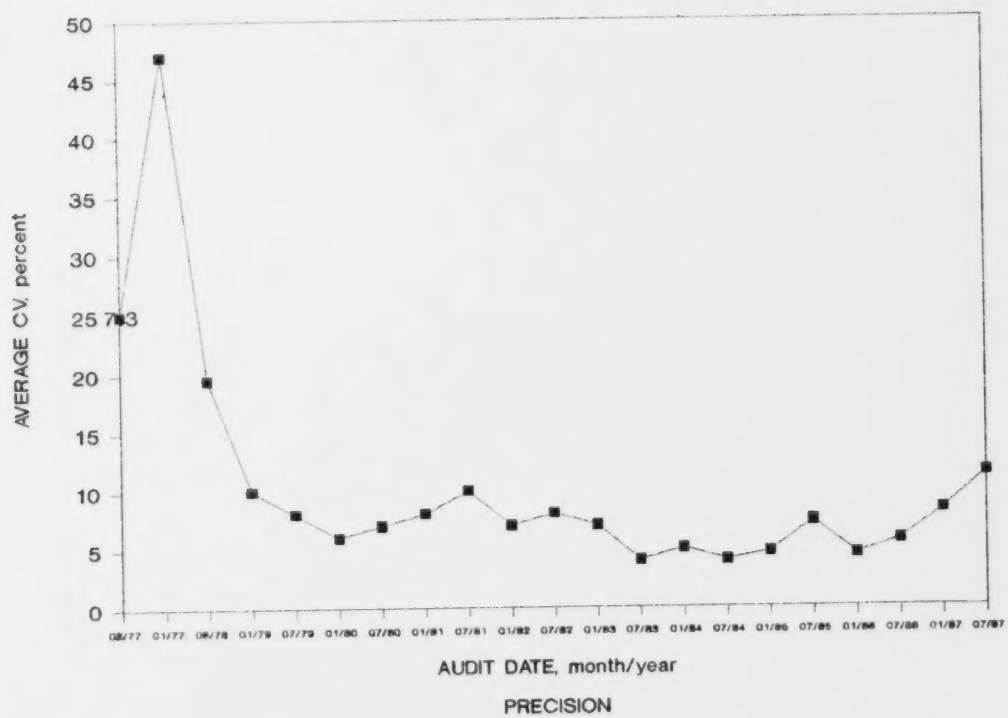
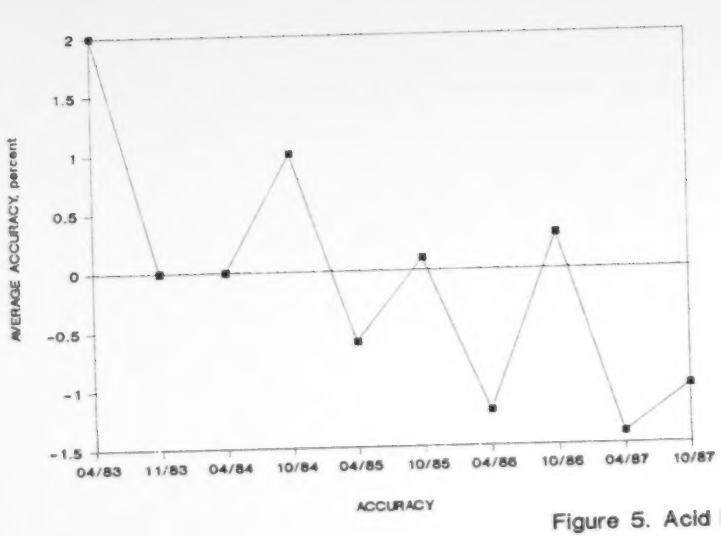


Figure 4. Lead Audits



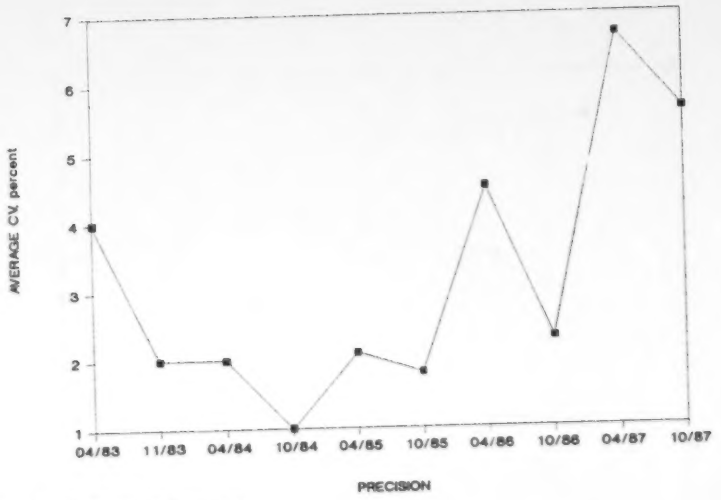
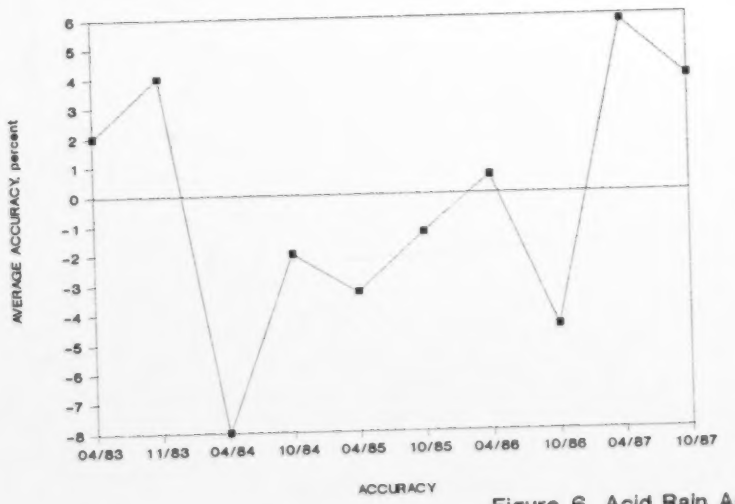


Figure 5. Acid Rain Audit Result for pH



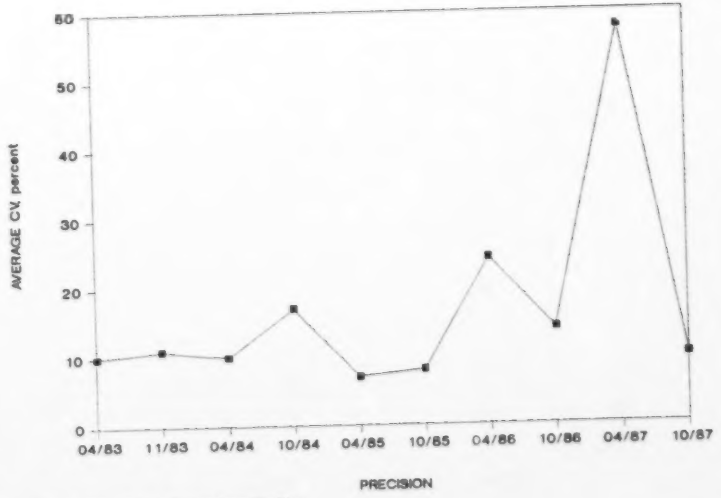


Figure 6. Acid Rain Audit Results for Conductivity

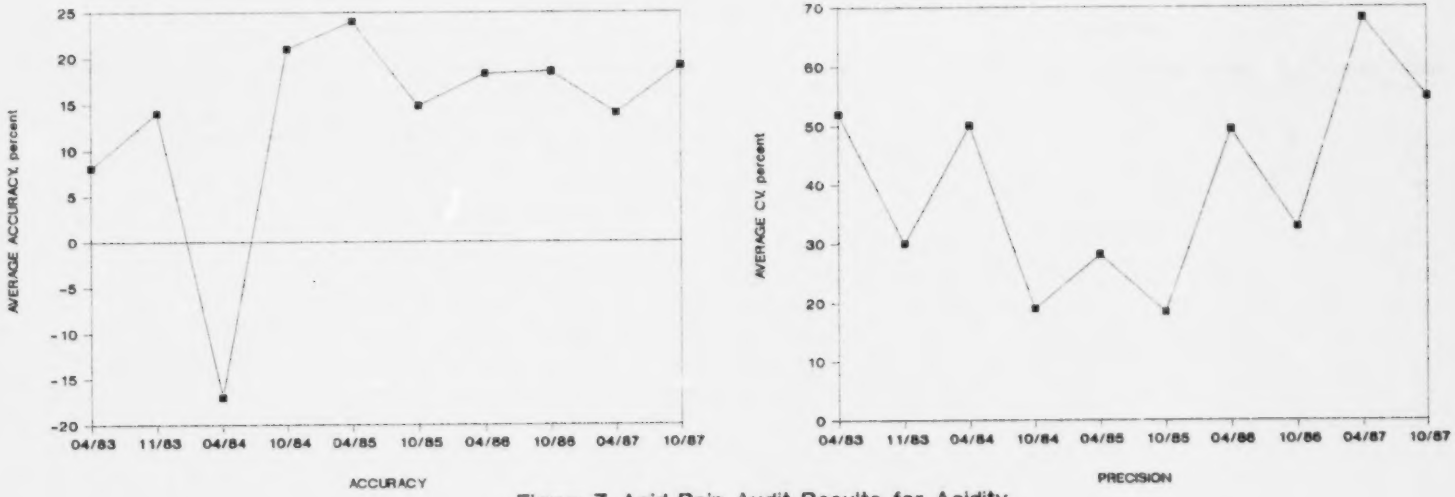


Figure 7. Acid Rain Audit Results for Acidity

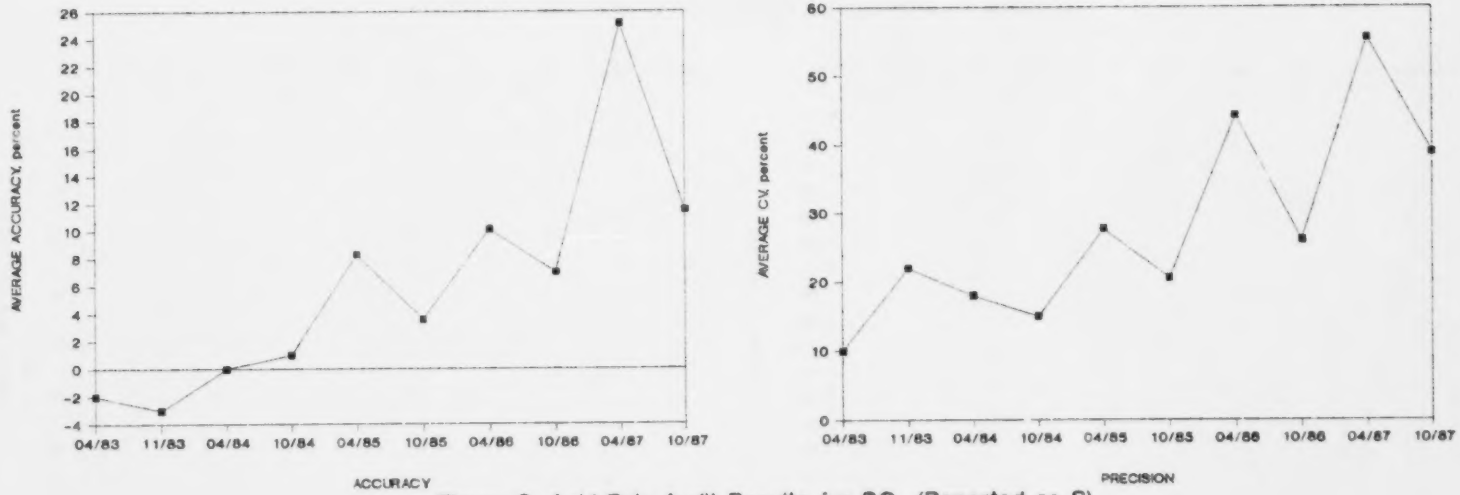
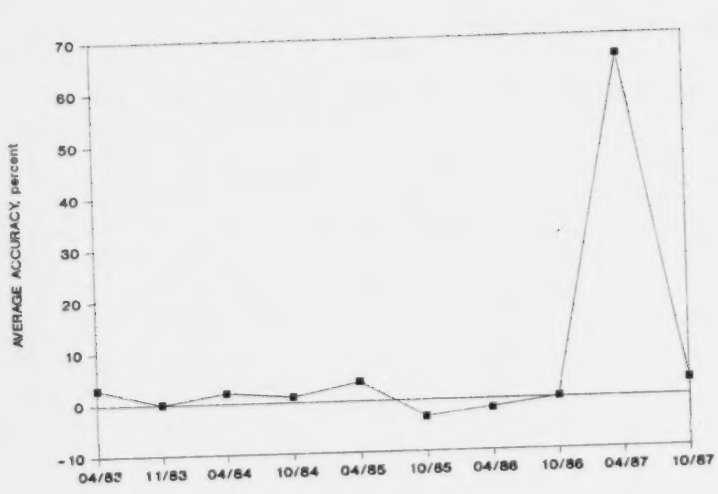


Figure 8. Acid Rain Audit Results for SO_4 (Reported as S)



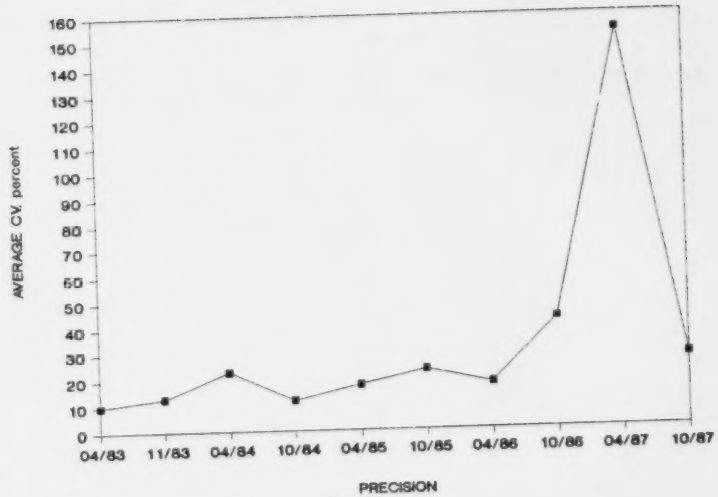
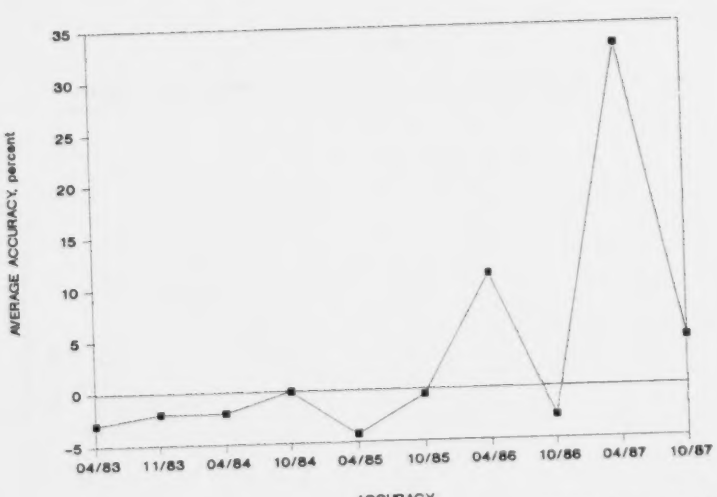


Figure 9. Acid Rain Audit Results for NO_3 (Reported as N)



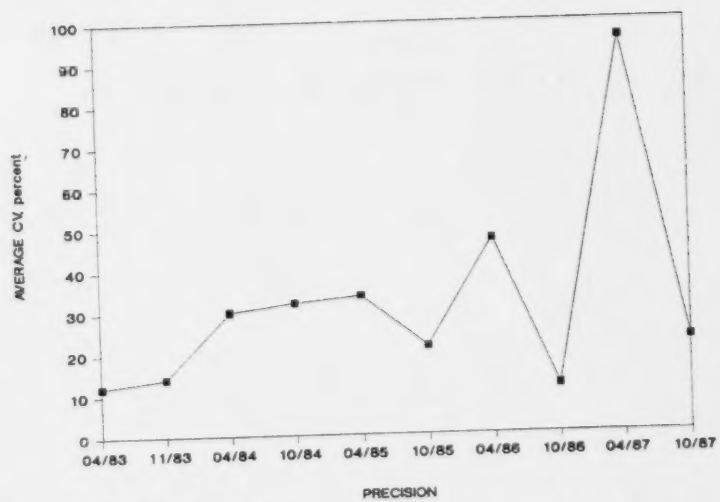
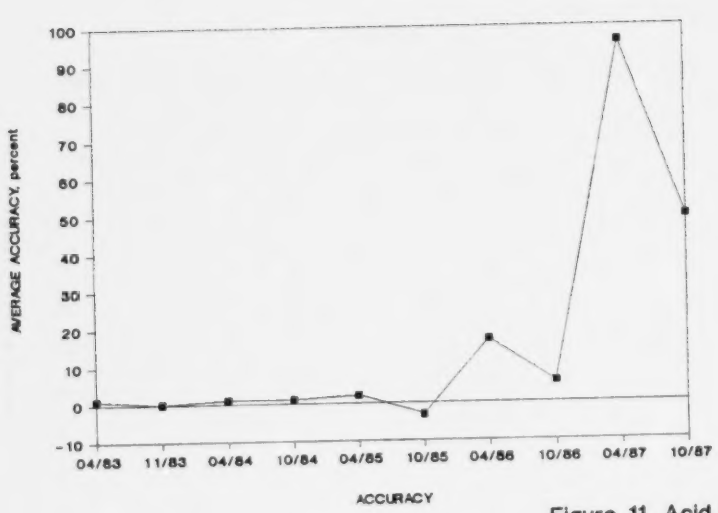


Figure 10. Acid Rain Audit Results for Cl



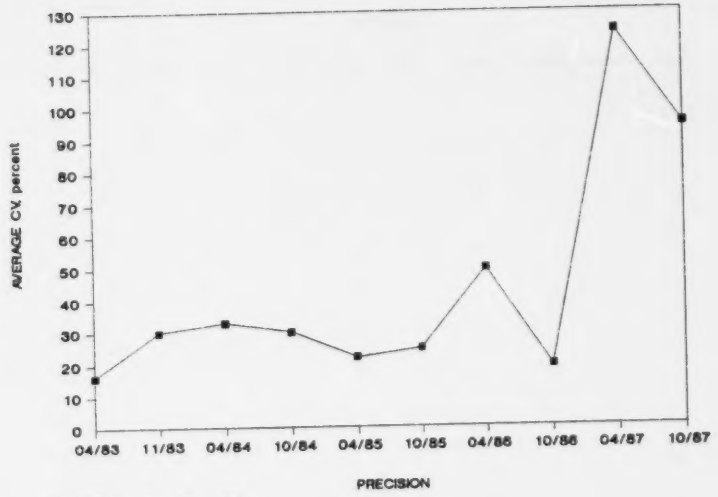
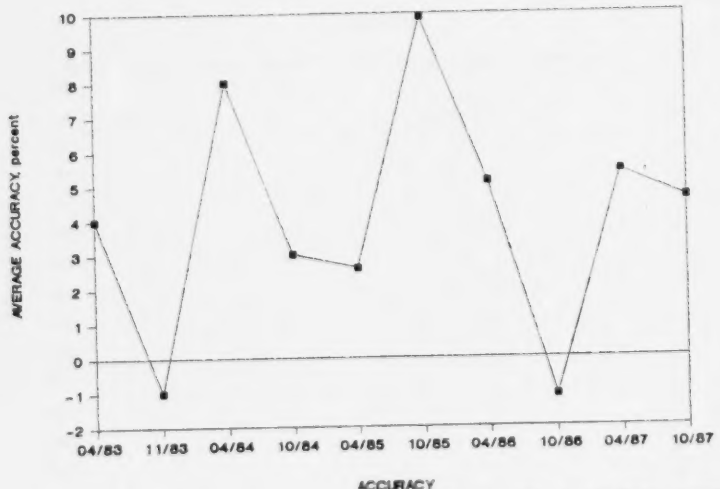


Figure 11. Acid Rain Audit Results for F



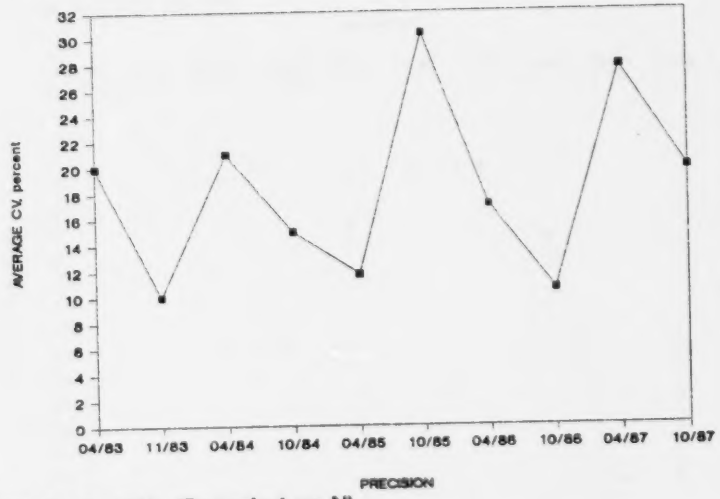
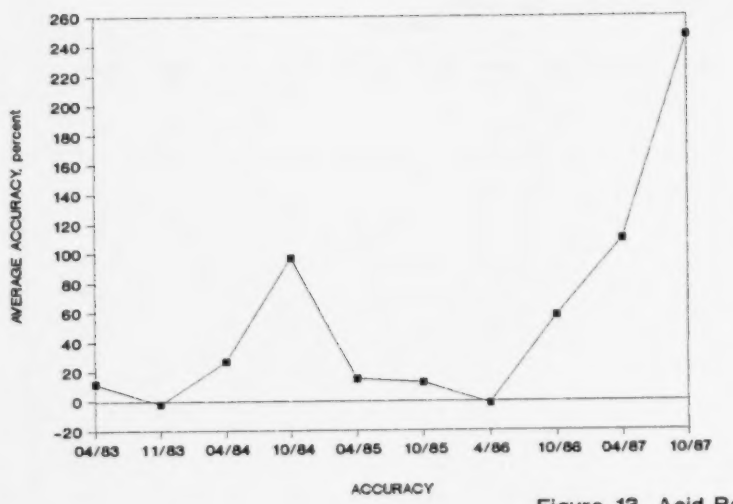


Figure 12. Acid Rain Audit Results for NH_4 (Reported as N)



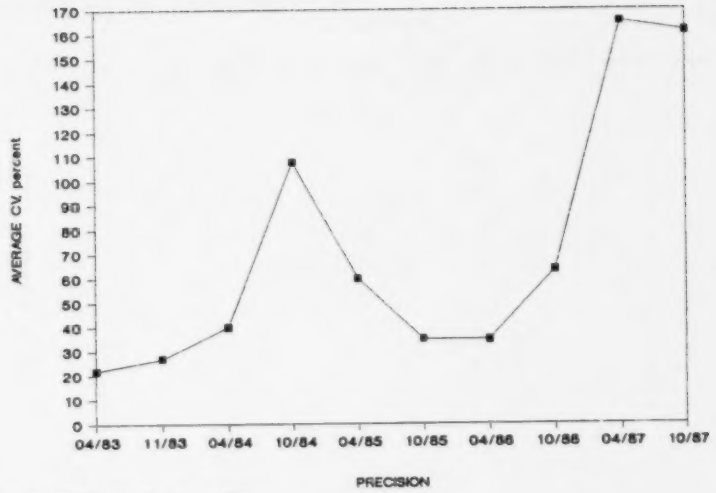
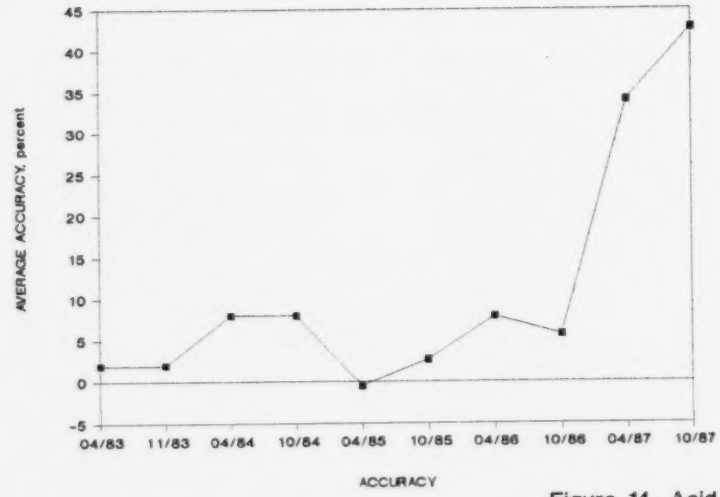


Figure 13. Acid Rain Audit Results for Ca



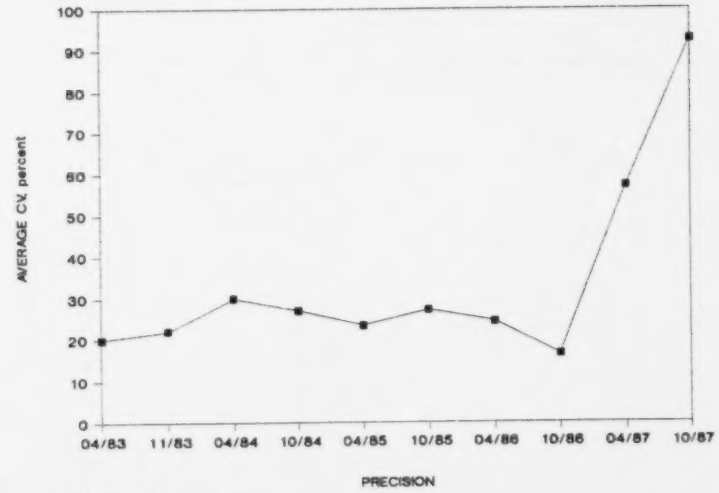
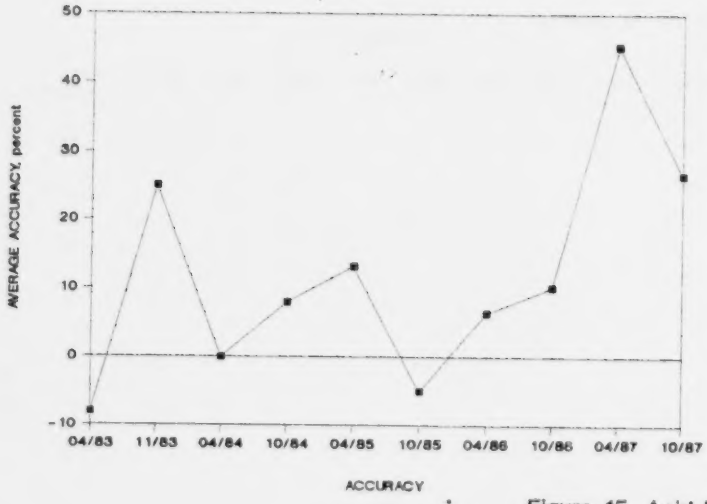


Figure 14. Acid Rain Audit Results for K



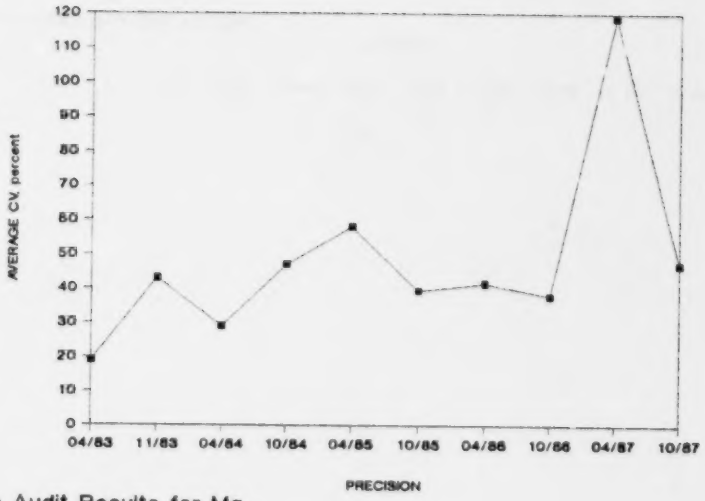
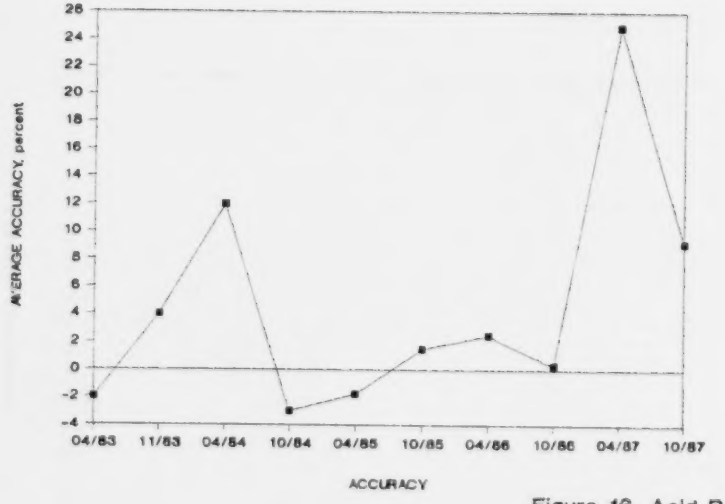


Figure 15. Acid Rain Audit Results for Mg



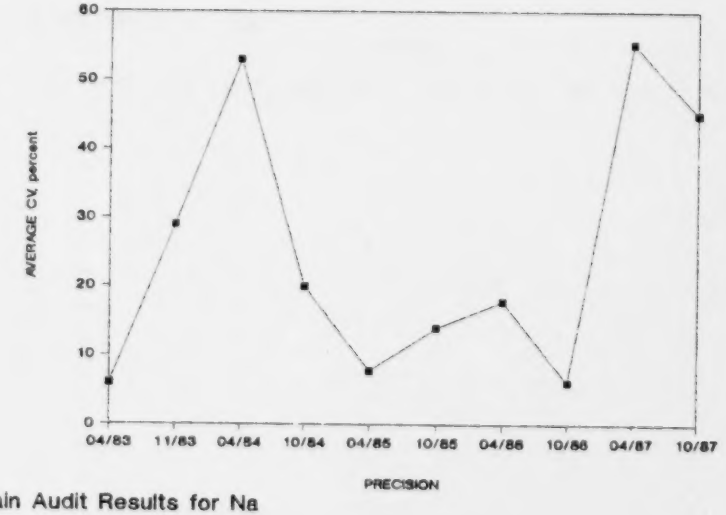


Figure 16. Acid Rain Audit Results for Na

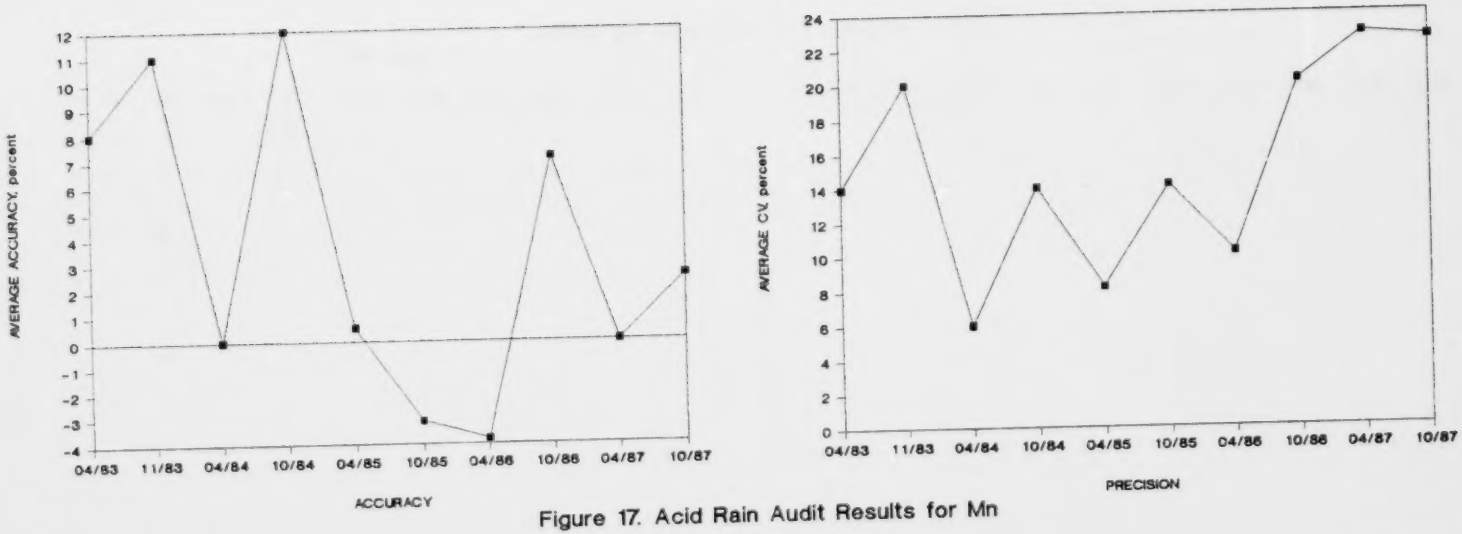


Figure 17. Acid Rain Audit Results for Mn

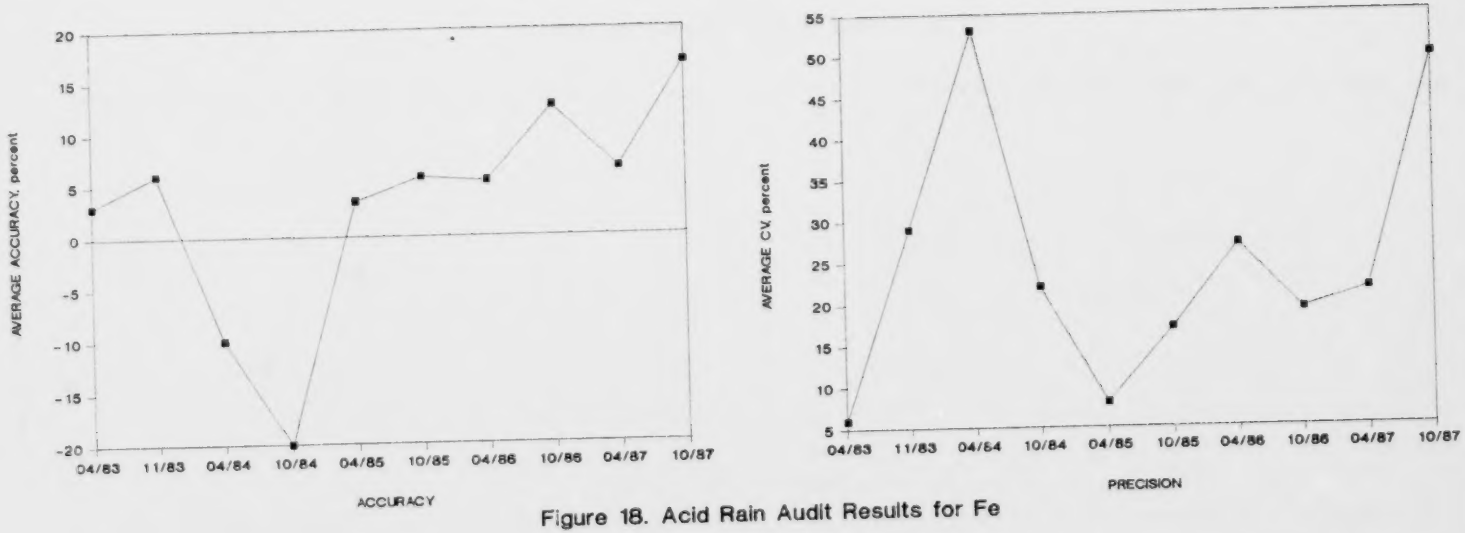


Figure 18. Acid Rain Audit Results for Fe

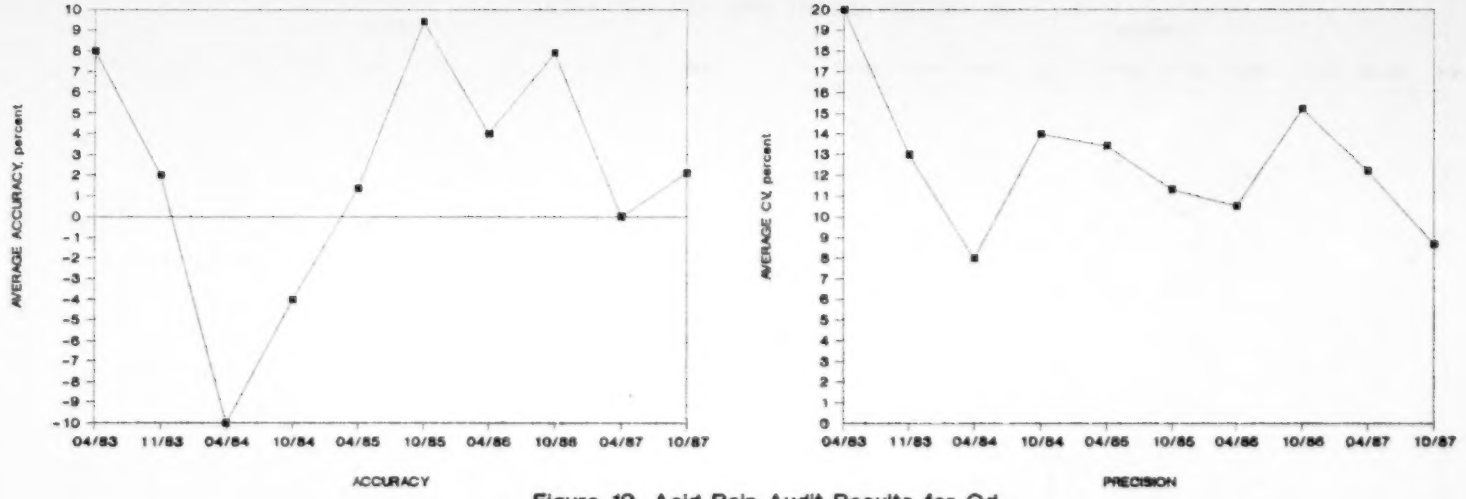


Figure 19. Acid Rain Audit Results for Cd

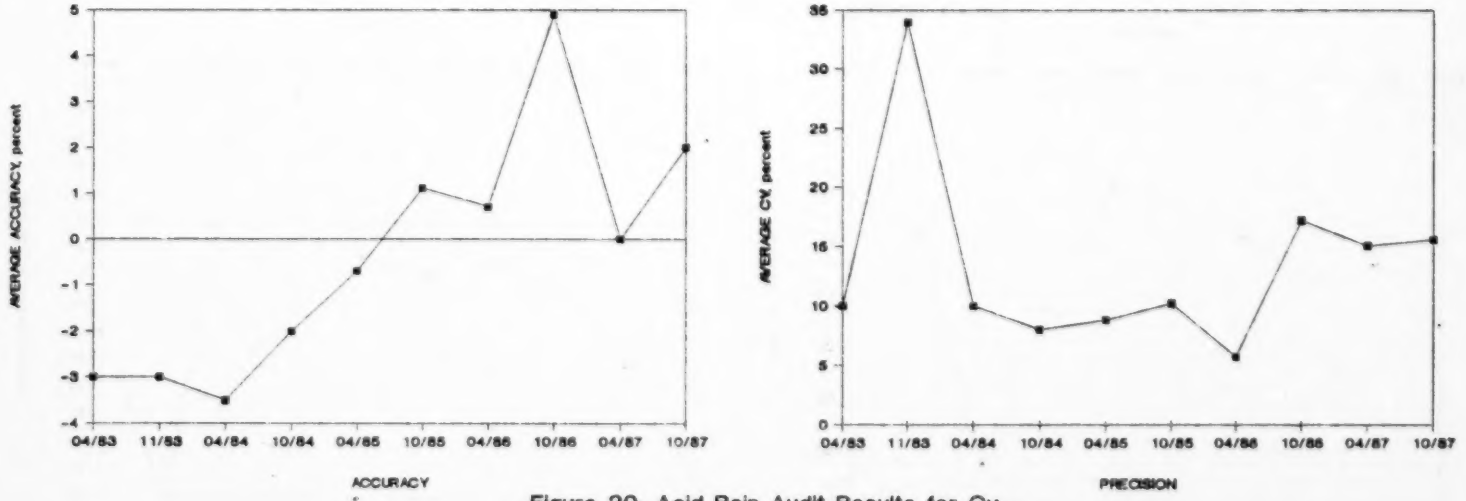


Figure 20. Acid Rain Audit Results for Cu

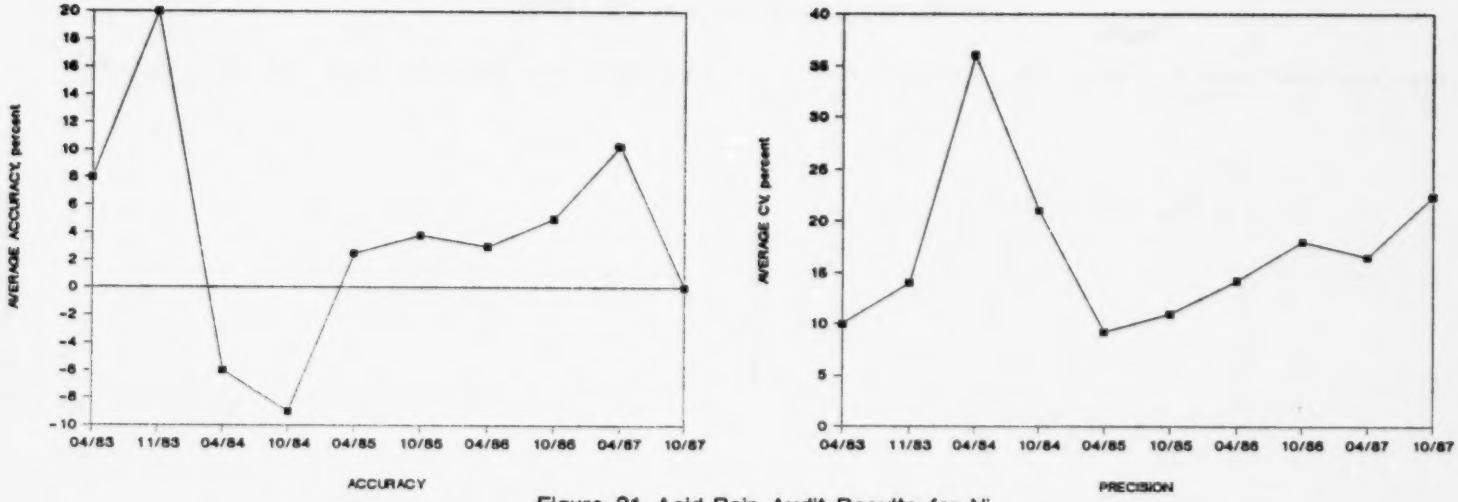


Figure 21. Acid Rain Audit Results for Ni

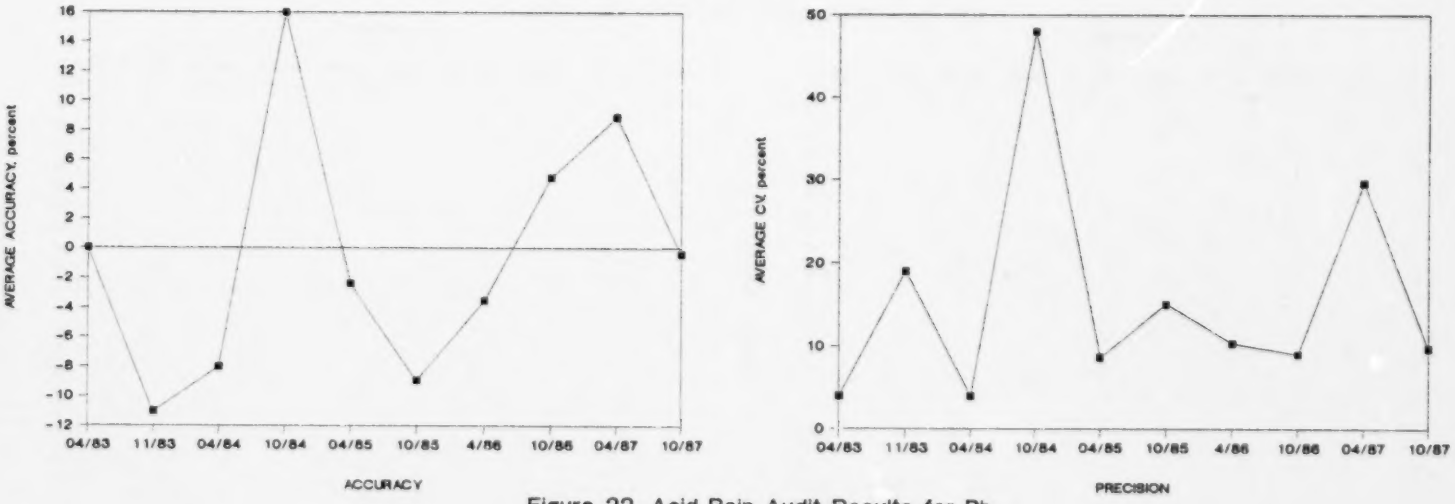


Figure 22. Acid Rain Audit Results for Pb

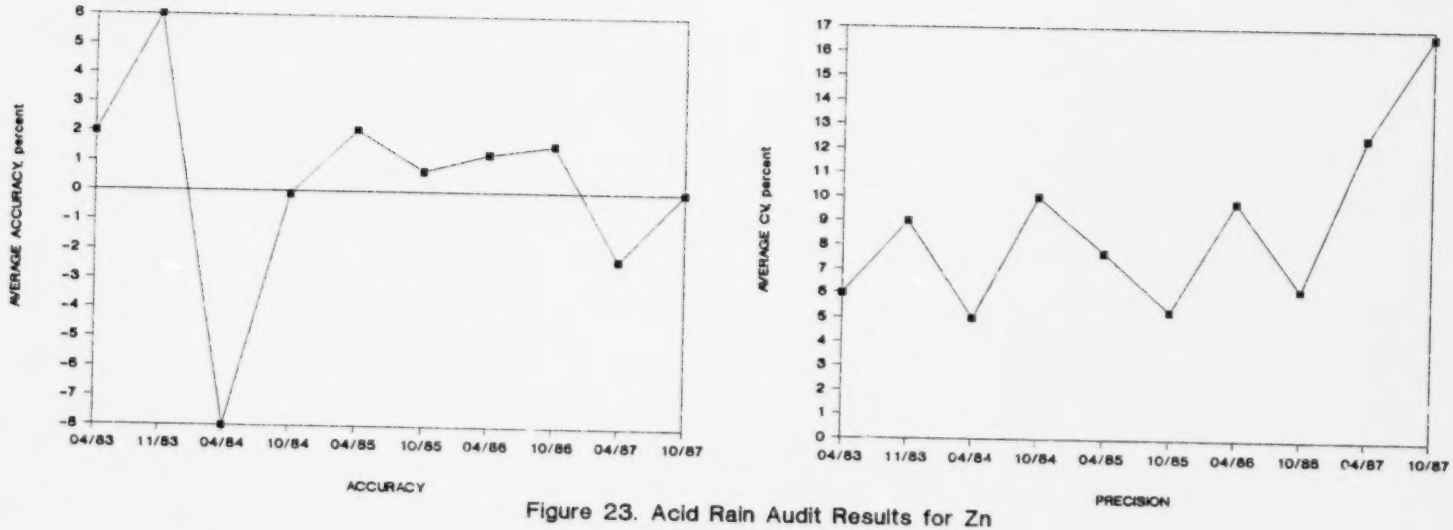


Figure 23. Acid Rain Audit Results for Zn

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